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## NEW CHAPTERS IN THE WARFARE OF SCIENCE.

### XI. FROM BABEL TO COMPARATIVE PHILOLOGY.

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PART I.

AMONG the sciences which have served as entering wedges into the heavy mass of ecclesiastical orthodoxy, to cleave it, disintegrate it, and let the light of Christianity into it, none perhaps has done a more striking work than Comparative Philology. In one very important respect the history of this science differs from that of any other; for it is the only one whose results theologians have at last fully adopted as the result of their own studies. This adoption teaches a great lesson, since, while it has destroyed theological views cherished during many centuries, and obliged the Church to accept conclusions directly contrary to the plain letter of our sacred books, the result is clearly seen to have helped Christianity rather than to have hurt it. It has certainly done much to clear our religious foundations of the dogmatic rust which was eating into their structure.

How this result was reached, and why the Church has so fully accepted it, I shall endeavor to show in the present chapter.

In the very beginnings of recorded history we find explanations of the diversity of tongues, and naturally such explanations resort to supernatural intervention. The "law of wills and causes," formulated by Comte, is exemplified here as in so many other cases. That law is, that when men do not know the natural causes of things, they simply attribute them to wills like their own; thus they obtain a theory which provisionally takes the place of science, and this theory is very generally theological.

Examples of this recur to any thinking reader of history.

Before the simpler laws of astronomy were known, the sun was supposed to be trundled out into the heavens every day and the stars hung up in the firmament every night by the right hand of the Almighty. Before the laws of comets were known, they were thought to be missiles hurled by an angry God at a wicked world. Before the real cause of lightning was known, it was supposed to be the work of a good God in his wrath, or of evil spirits in their malice. Before the laws of meteorology were known, it was thought that rains were caused by the Almighty or his angels opening "the windows of heaven" to let down upon the earth "the waters that be above the firmament." Before the laws governing physical health were known, diseases were supposed to result from the direct interposition of the Almighty or of Satan. Before the laws governing mental health were known, insanity was generally thought to be diabolic possession.*

So, in this case, to account for the diversity of tongues, the direct intervention of the Divine Will was brought in. As this diversity was felt to be an inconvenience, it was attributed to the will of a Divine Being in anger. To explain this anger, it was held that it must have been provoked by human sin.

Out of this conception explanatory myths and legends grew as thickly and naturally as elms along water-courses; and of these the earliest form known to us is found in the Chaldean accounts. We see it first in the Chaldean legend of the Tower of Babel.

The inscriptions recently found among the ruins of Assyria have thrown a bright light into this and other scriptural myths and legends; the deciphering of the characters in these inscriptions by Grotefend, and the reading of the texts by George Smith, Oppert, Sayce, and others, have given us these traditions more nearly in their original form than they appear in our own Scriptures.

The Hebrew story of Babel, like so many other legends in the sacred books of the world, combined various elements. By a play upon words, such as the history of myths and legends frequently shows us, it wrought into one fabric the earlier explanations of the diversities of human speech and of the great ruined tower at Babylon. The name Babel (*bab-il*) means "Gate of God" or "Gate of the Gods." All modern scholars of note agree that this was the real significance of the name; but the Hebrew verb which signifies *to confound* resembles somewhat the word Babel, so that out of this resemblance, by one of the most common processes in the history of myth formations, came to the Hebrew

* Any one who wishes to realize the mediæval view of the direct personal attention of the Almighty to the universe, can perhaps do so most easily by looking over the engravings in the well-known Nuremberg Chronicle, representing him in the work of each of the six days, and resting afterward.

mind an indisputable proof that the tower was connected with the sudden confusion of tongues; and this became part of our theological heritage.

In our sacred books the account runs as follows:

"And the whole earth was of one language and of one speech.

"And it came to pass, as they journeyed from the east, that they found a plain in the land of Shinar; and they dwelt there.

"And they said one to another, Go to, let us make brick, and burn them thoroughly. And they had brick for stone, and slime had they for mortar.

"And they said, Go to, let us build us a city and a tower whose top may reach unto heaven; and let us make us a name, lest we be scattered abroad upon the face of the whole earth.

"And the Lord came down to see the city and the tower which the children of men builded.

"And the Lord said, Behold, the people is one, and they have all one language; and this they begin to do: and now nothing will be restrained from them which they have imagined to do.

"Go to, let us go down, and there confound their language, that they may not understand one another's speech.

"So the Lord scattered them abroad from thence upon the face of all the earth: and they left off to build the city.

"Therefore is the name of it called Babel; because the Lord did there confound the language of all the earth: and from thence did the Lord scatter them abroad upon the face of all the earth." (Genesis, xi, 1–9.)

Thus far the legend had been but slightly changed from the earlier Chaldean form in which it has since been found in the Assyrian inscriptions. Its character is very simple; to use the words of the most eminent English-speaking authority, Prof. Sayce, of Oxford, a clergyman of the Church of England, "It takes us back to the age when the gods were believed to dwell in the visible sky, and when man, therefore, did his best to rear his altars as near them as possible." And the eminent professor might have added that it takes us back also to a time when it was thought that Jehovah, in order to see the tower fully, was obliged to come down from his seat above the firmament. In its earlier Chaldean form the legend runs, that the gods, assisted by the winds, overthrew the work of the contrivers and introduced a diversity of tongues.

As to the real cause of the building of the tower there seems a substantial agreement among leading scholars that it was erected primarily as part of a temple, but largely for the purpose of astronomical observations, to which the Chaldeans were so devoted, and to which their country, with its level surface and clear atmosphere, was so well adapted. As to the real cause of its de-

struction, one of the inscribed cylinders discovered in recent times, speaking of a tower which most of the leading archæologists identify with the Tower of Babel, reads as follows:

"The building named the Stages of the Seven Spheres, which was the Tower of Borsippa, had been built by a former king. He had completed forty-two cubits, but he did not finish its head. During the lapse of time, it had become ruined; they had not taken care of the exit of the waters, so that rain and wet had penetrated into the brick-work; the casing of burned brick had swollen out, and the terraces of crude brick are scattered in heaps."

We can well understand how easily "the gods, assisted by the winds," as stated in the Chaldean legend, could overthrow a tower thus built.

It may be instructive to compare with the explanatory myth developed first by the Chaldeans, and in a slightly different form by the Hebrews, various other legends to explain the same diversity of tongues. The Hindoo legend of the confusion of tongues is as follows:

"There grew in the center of the earth the wonderful 'world tree' or 'knowledge tree.' It was so tall that it reached almost to heaven. It said in its heart: 'I shall hold my head in heaven and spread my branches over all the earth, and gather all men together under my shadow, and protect them, and prevent them from separating. But Brahma, to punish the pride of the tree cut off its branches and cast them down on the earth, when they sprang up as wata trees, and made differences of belief and speech and customs to prevail on the earth, to disperse men upon its surface."

Still more striking is a Mexican legend: according to this, Xelhua, one of the seven giants rescued from the flood, built the great Pyramid of Cholula, in order to reach heaven, until the gods, angry at his audacity, threw fire upon the building and broke it down, whereupon every separate family received a language of its own.

Such explanatory myths grew or spread widely over the earth. A well-known form of the legend, more like that of the Chaldeans than the Hebrew later form, appeared among the Greeks. According to this, the Aloidæ piled Mount Ossa upon Olympus and Pelion upon Ossa, in their efforts to reach heaven and dethrone Jupiter.

Still another form of it entered the thoughts of Plato. He held that in the golden age men and beasts all spoke the same language, but that Zeus confounded their speech because men were proud and demanded eternal youth and immortality.*

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* For the identification of the Tower of Babel with the "Birs Nimrud" amid the ruins of the city of Borsippa, see Sir Henry Rawlinson, and especially George Smith, Assyrian

But naturally the version of the legend which most affected Christendom was that modification of the Chaldean form developed among the Jews and embodied in their sacred books. To a thinking man in these days it is very instructive. The coming down of the Almighty from heaven to see the tower and put an end to it by dispersing its builders, points to the time when his dwelling was supposed to be just above the firmament or solid vault above the earth; the time when he exercised his beneficent activity in such acts as opening "the windows of heaven" to give down rain upon the earth; in bringing out the sun every day and hanging up the stars every night to give light to the earth; in hurling comets, to give warning; in placing his bow in the cloud, to give hope; in coming down in the cool of the evening to walk in the garden of Eden and to talk with the man he had made; in meeting one chosen man upon a mountain to give him laws, and another in the desert to wrestle with him.

But closely connected in its effects with this Babel legend was that of the naming of the animals by Adam. It was written in one of our two accounts of the creation that Jehovah came down and brought all the animals before Adam, who gave them their names. This and other indications of language, together with the Chaldean legend, which, in passing through the Jewish mind, became monotheistic, supplied to Christian theology the germs of a sacred science of philology. These germs developed rapidly in the warm atmosphere of devotion and ignorance of natural law which pervaded the early Christian Church; and so there grew a great

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Discoveries, p. 59. For a different view, see Lenormant, Histoire Ancienne de l'Orient, vol. i, p. 118. For some of these inscriptions discovered and read by George Smith, see his Chaldean Account of Genesis, New York, 1876, pp. 160–162. For the statement regarding the origin of the word Babel, see Ersch and Grüber, article Babel; also, the Rev. Prof. A. H. Sayce, in the latest edition of the Encyclopædia Britannica; also Colenso, Pentateuch examined, vol. iv, p. 268; also John Fiske, Myths and Myth-makers, p. 72; also Lenormant, Histoire Ancienne de l'Orient, Paris, 1881, vol. i, pp. 115 *et seq.* As to the character and purpose of the great tower of the Temple of Belus, see Smith's Bible Dictionary, article Babel, quoting Diodorus; also Rawlinson, especially in Journal of the Asiatic Society for 1861; also Sayce, Religion of the Ancient Babylonians (Hibbert Lectures for 1887), London, 1877, chap. ii and elsewhere, especially pp. 96, 397, 407; also Max Duncker, History of Antiquity, Abbott's translation, vol. ii, chaps. ii and iii. For similar legends in other parts of the world, see Delitch; also Humboldt, American Researches; also Brinton, Myths of the New World; also Colenso, as above. The Tower of Cholula is well known, having been described by Humboldt and Lord Kingsborough. For superb engravings showing the view of Babel as developed by the theological imagination, see Kircher, Turris Babel, Amsterdam, 1679. For the Law of Wills and Causes, with deductions from it well stated, see Beattie Crozier, Civilization and Progress, London, 1888, pp. 112, 178, 179, 273. For Plato, see the Polit., 272, ed. Steph., and elsewhere cited in Ersch and Grüber, article Babylon. For a good general statement, see Bible Myths, New York, 1883, chap. iii. For Aristotle's strange want of interest in any classification of the varieties of human speech, see Max Müller, Lectures on the Science of Language, London, 1864, series i, chap. iv, pp. 123–125.

orthodox theory of language, strong and apparently firm, which has lasted throughout Christendom for nearly two thousand years.

There had, indeed, come into human thought at the very earliest period some suggestions of the modern scientific view of philology. Lucretius had proposed a theory, inadequate indeed, but still pointing very directly toward the truth, as follows: "Nature impelled man to try the various sounds of the tongue, and so struck out the names of things, much in the same way as the inability to speak is seen in its turn to drive children to the use of gestures." But, among the early fathers of the Church, the only one who seems to have caught an echo of this truth was St. Gregory of Nyssa; as a rule, all the other great founders of Christian theology, as far as they expressed themselves on the subject, took the view that the original language spoken by the Almighty and given by him to men was Hebrew, and that from this all other languages were derived at the destruction of the Tower of Babel. This doctrine was especially upheld by Origen, St. Jerome, and St. Augustine. Origen taught that "the language given at the first through Adam, the Hebrew, remained among that portion of mankind which was assigned not to any angel, but continued the portion of God himself." St. Augustine declared that, when the other races were divided by their own peculiar languages, Heber's family preserved that language which is not unreasonably believed to have been the common language of the race, and that on this account it was henceforth called Hebrew. St. Jerome wrote, "The whole of antiquity affirms that Hebrew, in which the Old Testament is written, was the beginning of all human speech."

Amid such great authorities as these even Gregory of Nyssa struggled in vain. He seems to have taken the matter very earnestly, and to have used not only argument but ridicule. He insists that God does not speak Hebrew, and that the tongue used by Moses was not even a pure dialect of one of the languages resulting from "the confusion." He makes man the inventor of speech, and resorts to raillery: speaking against his opponent Eunomius, he says that "passing in silence his base and abject garrulity," he will "note a few things which are thrown into the midst of his useless or wordy discourse, where he represents God teaching words and names to our first parents, sitting before them like some pedagogue or grammar master." But, naturally, the great authority of Origen, Jerome, and Augustine prevailed; the view suggested by Lucretius, and again by St. Gregory of Nyssa, died out, and "always, everywhere, and by all" in the Church the doctrine was received that the language spoken by the Almighty was Hebrew; that it was taught by him to Adam, and that all other languages on the face of the

earth originated from it at the dispersion attending the destruction of the Tower of Babel.*

This idea threw out roots and branches in every direction, and so developed ever into new and strong forms. As all scholars now know, the vowel points in the Hebrew language were not adopted until at some period between the second and tenth centuries; but in the early Church they soon came to be considered as part of the great miracle—as the work of the right hand of the Almighty; and never until the eighteenth century was there any doubt allowed about the divine origin of these rabbinical additions to the text. To hesitate in believing that these points were dotted by the very hand of God himself came to be considered a fearful heresy.

The series of battles between Theology and Science in the field of comparative philology opened just on this little point, apparently so insignificant—the direct divine inspiration of the rabbinical punctuation. The first to impugn the divine origin of these vocal points and accents appears to have been a Spanish monk, Raymundus Martinus, in his Pugio Fidei, or Poniard of the Faith, which he put forth in the thirteenth century. But he and his doctrine disappeared beneath the waves of the orthodox ocean, and apparently left no trace. For nearly three hundred years longer the full sacred theory held its ground; but about the opening of the sixteenth century another glimpse of the truth was given by a Jew, Elias Levita, and this seems to have had some little effect, at least in keeping the germ of scientific truth alive.

The Reformation, with its renewal of the literal study of the Scriptures, and its transfer of all infallibility from the Church and the Papacy to the letter of the sacred books, did not abate but rather intensified for a time the devotion of Christendom to this sacred theory of language. Only on this one question—the origin of the Hebrew points—was there any controversy, and this waxed hot. It began to be especially noted that these vowel points in the Hebrew Bible seemed unknown to St. Jerome and his compeers; and on this ground, supported by a few other au-

* For Lucretius's statement, see the De Rerum Natura, lib. v, Monro's edition, with translation, Cambridge, 1886, vol. iii, p. 141. For the opinion of Gregory of Nyssa, see Benfey, Geschichte der Sprachwissenschaft in Deutschland, München, 1869; p. 179; and for the passage cited, see Gregory of Nyssa in his Contra Eunomium, xii, Patr. Græca, Paris, 1858, vol. ii, p. 1043. For St. Jerome, see the Epistle, xviii, p. 365, Migne, tome xxii, Paris, 1842. For citation from St. Augustine, see the City of God, Dod's translation, Edinburgh, 1871, vol. ii, p. 122. For citation from Origen, see Homily xi, cited by Guichard in preface to l'Harmonie étymologique, Paris, 1631, lib. xvi, c. xi. For absolutely convincing proofs that the Jews derived the Babel and other legends of their sacred books from the Chaldeans, see George Smith, Chaldean Account of Genesis, *passim*; but especially for a most candid though evidently somewhat reluctant summing up, see page 291.

thorities, some earnest men ventured to think them no part of the original revelation to Adam. Zwingli, so much before most of the Reformers in other respects, was equally so in this. While not doubting the divine origin and preservation of the Hebrew language as a whole, he denied the antiquity of the vocal points, demonstrated their unessential character, and pointed out the fact that St. Jerome makes no mention of them. His denial was long the refuge of those who shared this heresy.

But the full orthodox theory remained established among the vast majority both of Catholics and Protestants. Illustrative of the attitude of the former is the imposing work of the canon Marini, which appeared at Venice in 1593, under the title of Noah's Ark: A New Treasury of the Sacred Tongue. The huge folios begin with the declaration that the Hebrew tongue was "divinely inspired at the very beginning of the world," and the doctrine is steadily maintained that this divine inspiration extended not only to the letters but to the vocal punctuation.

Not before the seventeenth century was well under way do we find a thorough scholar bold enough to gainsay this preposterous doctrine. This new assailant was Capellus, Professor of Hebrew at Saumur; but even he dared not put forth his argument in France. He was obliged to publish it in Holland, and even there such obstacles were thrown in his way that it was ten years before he published another treatise of importance.

The work of Capellus was received by very many open-minded scholars as settling the question, and among these was Hugo Grotius. But many theologians felt this view to be a blow at the sanctity and integrity of the sacred text; and in 1648 the great scholar, John Buxtorf, rose to defend the orthodox citadel: in his Anticritica he brought all his stores of knowledge to defend the doctrine that the rabbinical points and accents had been jotted down by the right hand of God.

The controversy waxed hot; scholars like Voss and Brian Walton supported Capellus. Wasmuth and many others of note were as fierce against him. The Swiss Protestants were especially violent on the orthodox side. The Calvinists of Geneva, in 1678, by a special canon, forbade that any minister should be received into their jurisdiction until he publicly confessed that the Hebrew text, as it to-day exists in the Masoretic copies, is, both as to the consonants and vowel points, divine and authentic.

While in Holland so great a man as Hugo Grotius supported the view of Capellus, and while in France the eminent Catholic scholar Richard Simon, and many others, Catholic and Protestant, took similar ground against this divine origin of the Hebrew punctuation, there was arrayed against them a body apparently overwhelming. In France, Bossuet, the greatest theologian that

France has ever produced, did his best to crush Simon. In Germany, Wasmuth, professor first at Rostock and afterward at Kiel, hurled his "Vindiciæ" at the innovators. Yet at this very moment the battle was clearly won; the arguments of Capellus were irrefragable, and, despite the commands of bishops, the outcries of theologians and the sneering of critics, his application of strictly scientific observation and reasoning carried the day.

Yet a casual observer, long after the fate of the battle was really settled, might have supposed that it was still in doubt. As is not unusual in theologic controversies, attempts were made to galvanize the dead doctrine into the appearance of life. Famous among these attempts was that made as late as the beginning of the eighteenth century by two Bremen theologians, Hase and Iken. They put forth a compilation in two huge folios simultaneously at Leyden and Amsterdam, prominent in which work is the treatise on The Integrity of Scripture, by Johann Andreas Danzius, Professor of Oriental Languages and Senior Member of the Philosophical Faculty of Jena. To preface it, there was a formal and fulsome approval by three eminent professors of theology at Leyden. With great fervor the author pointed out that "religion itself depends absolutely on the infallible inspiration, both verbal and literal, of the Scripture text"; and with impassioned eloquence he assailed the blasphemers who dared question the divine origin of the Hebrew points. But this was really the last great effort. That the case was lost is seen by the fact that Danzius felt obliged to use other missiles than arguments, and especially to call his opponents hard names. From this period the old sacred theory as to the origin of the Hebrew points may be considered as dead and buried.

But the war was soon to be waged on a wider and far more important field. The inspiration of the Hebrew punctuation having been given up, the great orthodox body fell back upon the remainder of the theory, and intrenched this more strongly than ever—the theory that the Hebrew language was the first of all languages, spoken by the Almighty, given by him to Adam, transmitted through Noah to the world after the Deluge, and that the confusion of tongues was the origin of all the other languages of the earth. In giving account of this new phase of the struggle, it is well to go back a little. From the revival of learning and the Reformation had come the renewed study of Hebrew in the fifteenth and sixteenth centuries, and thus the sacred doctrine regarding the divine origin of the Hebrew language received additional authority. All the early Hebrew grammars, from that of Reuchlin down, assert the divine origin and miraculous claims of Hebrew. It is constantly mentioned as "the sacred tongue"—*sancta lingua*. In 1506 Reuchlin, though himself persecuted by a

large faction in the Church for advanced views, refers to Hebrew as "spoken by the mouth of God."

This idea was popularized by the 1508 edition of the Margarita Philosophica, published at Strasburg. That work—in its successive editions a mirror of human knowledge at the close of the middle ages and the opening of modern times—contains a curious introduction to the study of Hebrew. In this it is declared that Hebrew was the original speech, "used between God and man and between men and angels." Its full-page frontispiece represents Moses receiving from God the tables of stone written in Hebrew; and, as a conclusive argument, it reminds us that Christ himself, by choosing a Hebrew maid for his mother, made that his mother-tongue.

It must be noted here, however, that Luther, in one of those outbursts of strong sense which so often appear in his career, enforced the explanation that the words "God said" had nothing to do with the voice or articulation of human language. Still, he evidently yielded to the general view. In the Roman Church at the same period we have a typical example of the theologic method in the statement by Luther's great opponent, Cajetan, that the three languages of the inscription on the cross of Calvary "were the representatives of all languages," and he gives as the reason for this the fact that "the number three denotes perfection."

In 1538 Postillus made a very important endeavor at a comparative study of languages, but with the orthodox assumption that all were derived from one source, namely, the Hebrew. Naturally, Comparative Philology blundered and stumbled on in this path with endless absurdities. The most amazing efforts were made to trace back everything to the sacred language. English and Latin dictionaries appeared, in which every word was traced back to a supposed Hebrew root. No supposition was too absurd in this attempt to square Science with Scripture. It was declared that, as Hebrew is written from right to left, it might be read either way, in order to produce a satisfactory etymology. The whole effort in all this sacred scholarship was, not to find what the truth is; not to see how the various languages are to be classified, or from what source they are really derived, but to demonstrate what was supposed necessary to maintain the truth of Scripture, namely, that all languages are derived from the Hebrew.

This stumbling and blundering, under the sway of this orthodox necessity, is seen among the foremost scholars throughout Europe. About the middle of the sixteenth century the great Swiss scholar, Conrad Gesner, beginning his Mithridates, says, "While of all languages Hebrew is the first and oldest, of all is

alone pure and unmixed, all the rest are much mixed, for there is none which has not some words derived and corrupted from Hebrew."

Typical, as we approach the end of the sixteenth century, are the utterances of two of the most noted English divines: First of these may be mentioned Dr. William Fulke, Master of Pembroke Hall, in the University of Cambridge. In his Discovery of the Dangerous Rock of the Romish Church, published in 1580, he speaks of "the Hebrew tongue, . . . the first tongue of the world, and for the excellency thereof called 'the holy tongue.'"

Yet more strong, eight years later, was another eminent divine, Dr. William Whitaker, Regius Professor of Divinity and Master of St. John's College at Cambridge. In his Disputation on Holy Scripture, first printed in 1588, he says: "The Hebrew is the most ancient of all languages, and was that which alone prevailed in the world before the Deluge and the erection of the Tower of Babel. For it was this which Adam used and all men before the Flood, as is manifest from the Scriptures, as the Fathers testify." He then proceeds to quote passages on this subject from St. Jerome, St. Augustine, and others. He cites St. Chrysostom in support of the statement that "God himself showed the model and method of writing when he delivered the Law written by his own finger to Moses." *

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* For the whole scriptural argument, embracing the various texts on which the Sacred Science of Philology was founded, with the use made of such texts, see Benfey, Geschichte der Sprachwissenschaft in Deutschland, München, 1869, pp. 22–26. As to the origin of the vowel-points, see Benfey, as above: he holds that they began to be inserted in the second, and that the process lasted until about the tenth century A. D. For Raymundus and his Pugio Fidei, see G. L. Bauer, Prolegomena to his Revision of Glassius's Philologia Sacra, Leipsic, 1795; see especially pp. 8–14, in tome ii of the work. For Zwingli, see Traef. in Apol. comp. Jesaiæ (Opera iii): Cf. e. g. Morinus, De Lingua primæva, p. 447. For Marini, see his Arca Noe: Thesaurus, Linguæ Sanctæ, Venet., 1593, and especially the preface. For general account of Capellus, see G. L. Bauer, in his Prolegomena, as above, Leipsic, 1795, vol. ii, pp. 8–14. His Arcanum Premetationis Revelatum was brought out at Leyden in 1624; his Critica Sacra ten years later. See on Capellus and Swiss theologues, Wolfius, Bibliotheca Nebr., tome ii, p. 27. For the struggle, see Schnedermann, Die Controverse des Ludovicus Capellus mit dem Buxtofen, Leipsic, 1879: cited in article Hebrew, in Encyclopædia Britannica. For Wasmuth, see his Vindiciæ Sanctæ Hebraicæ Scripturæ, Rostock, 1664. For Reuchlin, see the dedicatory preface to his Rudimenta Hebraica, Pforzheim, 1506, folio, in which he speaks of the "in divina scriptura dicendi genus, quale os Dei locutum est." The statement in the Margarita Philosophica as to Hebrew is doubtless based on Reuchlin's Rudimenta Hebraica, which it quotes, and which first appeared in 1506. It is significant that this section disappeared from the Margarita in the following editions; but this disappearance is easily understood when we recall the fact that Gregory Reysch, its author, having become one of the Papal Commission to judge Reuchlin in his quarrel with the Dominicans, thought it prudent to side with the latter, and therefore, doubtless, considered it wise to suppress all evidence of Reuchlin's influence upon his beliefs. All the other editions of the Margarita in my possession are content with teaching, under the head of the Alphabet, that the

This sacred theory entered the seventeenth century in full force, and seems to have swept everything before it. The great commentators, Catholic and Protestant, accepted and developed it. Great prelates, Catholic and Protestant, stood guard over it, favoring those who supported it, doing their best to destroy those who would modify it.

In 1606 Stephen Guichard built new buttresses for it in Catholic France. He explains in his preface that his intention is "to make the reader see in the Hebrew word not only the Greek and Latin, but also the Italian, the Spanish, the French, the German, the Fleming, the English, and many others from all languages." As the merest tyro in philology can now see, the great difficulty that Guichard encounters is in getting from the Hebrew to the Aryan group of languages. How he meets this difficulty may be imagined from his statement, as follows: "As for the derivation of words by addition, subtraction, and inversion of the letters, it is certain that this can and ought thus to be done, if we would find etymologies—a thing which becomes very credible when we consider that the Hebrews wrote from right to left and the Greeks and others from left to right. All the learned recognize such derivations as necessary; . . . and . . . certainly otherwise one could scarcely trace any etymology back to Hebrew."

Of course, by this method of philological juggling, anything could be proved which the author thought necessary to maintain his pious theory.

Two years later, Andrew Willett published at London his Hexapla, or Six-fold Commentary upon Genesis. In this he insists that the one language of all mankind in the beginning "was the Hebrew tongue preserved still in Heber's family." He also takes pains to say that the Tower of Babel "was not so called of Belus, as some have imagined, but of confusion, for so the Hebrew word *ballal* signifieth"; and he quotes from St. Chrysostom to strengthen his position.

In 1627 Dr. Constantine l'Empereur was inducted into the chair of Philosophy of the Sacred Language in the University of

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Hebrew letters were invented by Adam. On Luther's view of the words "God said," see Farrar, Language and Languages. For a most valuable statement regarding the clashing opinions at the Reformation, see Max Müller, as above, lecture iv, p. 132. Both Müller and Benfey note, as especially important, the difference between the Church view and the ancient heathen view regarding "barbarians." See Müller, as above, lecture iv, p. 127, and Benfey, as above, p. 170 *et seq.* For a very remarkable list of Bibles printed at an early period, see Benfey, p. 569. For quotation beginning with the words Dictionaries of Latin and English, see Sayce. For Gesner, see his Mithridates (de differentiis linguarum), Zurich, 1555. For a similar attempt to prove that Italian was also derived from Hebrew, see Giambullari, cited in Garlanda, p. 174. For Fulke, see the Parker Society's publications, 1848, p. 224. For Whitaker, see reprint in the Parker Society's publications for 1849, pp. 112–114.

Leyden. In his inaugural oration on The Dignity and Utility of the Hebrew Tongue, he puts himself emphatically on record in favor of the divine origin and miraculous purity of that language. "Who," he says, "can call in question the fact that the Hebrew idiom is coeval with the world itself, save such as seek to win vainglory for their own sophistry by obscuring the truth?"

Two years after Willett, in England, comes the famous Dr. Lightfoot, one of the renowned scholars of his time in Hebrew, Greek, and Latin; but all his scholarship was bent to suit theological requirements. In his "Erubhin," or Miscellanies, published in 1629, he goes to the full length of the sacred theory, though we begin to see a curious endeavor to get over some linguistic difficulties. One passage will serve to show both the robustness of his faith and the acuteness of his reasoning, in view of the difficulties which scholars now began to find in the sacred theory: "Other commendations this tongue (Hebrew) needeth none than what it hath of itself; namely, for sanctity it was the tongue of God; and for antiquity it was the tongue of Adam. God the first founder, and Adam the first speaker of it . . . It began with the world and the Church, and continued and increased in glory till the captivity in Babylon . . . As the man in Seneca, that through sickness lost his memory and forgot his own name, so the Jews, for their sins, lost their language and forgot their own tongue . . . Before the confusion of tongues all the world spoke their tongue and no other; but, since the confusion of the Jews, they speak the language of all the world and not their own."

But just at the middle of the century (1657) came in England a champion of the sacred theory more important than any of these—Brian Walton, Bishop of Chester. His Polyglot Bible, with its prolegomena, dominated English scriptural criticism throughout the remainder of the century. He begins his great work by proving at length the divine origin of Hebrew, and the derivation from it of all other forms of speech. He declares it "probable that the first parent of mankind was the inventor of letters." His chapters on this subject are full of interesting details. He says that the Welshman, Davis, had already tried to prove the Welsh the primitive speech; Wormius, the Danish; Mitilerius, the German; but the bishop stands firmly by the sacred theory, declaring that "even in the New World are found traces of the Hebrew tongue, namely, in New England and in New Belgium, where the word *Aguarda* signifies earth, and the name Joseph is found among the Hurons." As we have seen, Bishop Walton had been forced to give up the inspiration of the rabbinical punctuation, but he seems to have fallen back with all the more tenacity on what remained of the great sacred theory of

language, and to have become its leading champion among English-speaking peoples.

At this same period we have the same doctrine put forth by a great authority in Germany. In 1657 Andreas Sennert published his inaugural address as Professor of Sacred Letters and Dean of the Theological Faculty at Wittenberg. All his efforts are given to making Luther's old university a fortress of the orthodox theory. His address, like many others in various parts of Europe, shows that in his time an inaugural with any save an orthodox statement of the theological platform would hardly have been tolerated. There are few things in the past to the sentimental mind more pathetic, to the philosophical mind more natural, and to the progressive mind more ludicrous, than most addresses on such occasions before assemblages of learned theologians at high festivals of great theological schools. The audience has generally consisted mainly of estimable elderly gentlemen, who received their theology in their youth, and who in their old age have watched over it with jealous care to see that it is well coddled and protected from any fresh breeze of thought. Naturally, then, a theological professor inaugurated under these circumstances has endeavored to propitiate his audience. Sennert goes to great lengths both in this and in his grammar, published nine years later, for, declaring the divine origin of Hebrew to be quite beyond controversy, he says: "Noah received it from our first parents, and guarded it in the midst of the waters; Heber and Peleg saved it from the confusion of tongues."

The same doctrine was no less loudly insisted upon by the greatest authority in Switzerland, Buxtorf, professor at Basle, who proclaimed Hebrew to be "the tongue of God, the tongue of angels, the tongue of the prophets"; and the effect of this proclamation may be imagined when we note in 1663 that his book had reached its sixth edition.

It was re-echoed through England, Holland, Germany, France, and America, and, if possible, yet more highly developed. In England Theophilus Gale sets himself to prove that not only all the languages, but all the learning of the world, have been drawn from the Hebrew records.

The orthodox doctrine was also fully vindicated in Holland. Six years before the close of the seventeenth century, Morinus, Doctor of Theology, Professor of Oriental Languages, and pastor at Amsterdam, published his great work on Primæval Language. Its frontispiece depicts the confusion of tongues at Babel, and, as a pendant to this, the pentecostal gift of tongues to the apostles. In the successive chapters of the first book he proves that language could not have come into existence save as a direct gift from heaven; that there is a primitive language, the mother of

all the rest; that this primitive language still exists in its pristine purity; that this language is the Hebrew. The second book is devoted to proving that the Hebrew letters were divinely received, have been preserved intact, and are the source of all other alphabets. But in the third book he feels obliged to declare, in the face of the contrary dogma held, as he says, by "not a few most eminent men piously solicitous for the authority of the sacred text," that the Hebrew punctuation was, after all, not of divine inspiration, but a late invention of the rabbis.

France, also, was held to all appearance in complete subjection to the orthodox idea up to the end of the century. In 1697 appeared at Paris perhaps the most learned of all the books written to prove Hebrew the original tongue and source of all others. The Gallican Church was then at the height of its power. Bossuet as bishop, as thinker, and as an adviser of Louis XIV, had crushed all opposition to orthodoxy. The Edict of Nantes had been revoked; and the Huguenots, so far as they could escape, were scattered throughout the world, destined to repay France with interest a thousand-fold during the next two centuries. The bones of the Jansenists were dug up and scattered at Port Royal. Louis XIV stood guard over the piety of his people. It was in the midst of this series of triumphs that Father Louis Thomassin, Priest of the Oratory, issued his Universal Hebrew Glossary. In this, to use his own language, "the divinity, antiquity, and perpetuity of the Hebrew tongue, with its letters, accents, and other characters," are established forever and beyond all cavil, by proofs drawn from all peoples, kindred, and nations under the sun. This superb, thousand-columned folio was issued from the royal press, and is one of the most imposing monuments of human piety and folly; taking rank with the great treatises of Fromundus against Galileo, of Quaresmius on Lot's Wife, and of Gladstone on Genesis and Geology.

The great theologic-philologic chorus was steadily maintained, and, as in an antiphonal chant, its doctrines were echoed from land to land. From America there came the earnest words of noble John Eliot, praising Hebrew as the most fit to be made a universal language, and declaring it the tongue "which it pleased our Lord Jesus to make use of when he spake from heaven unto Paul." At the close of the seventeenth century comes, as it were, a strong antiphonal answer in this chorus from England. Meric Casaubon, the learned Prebendary of Canterbury, thus declares: "One language, the Hebrew, I hold to be simply and absolutely the source of all." And, to make the chorus perfect, there came into it, in complete unison, the voice of Bentley—the greatest scholar of the old sort whom England has ever produced. He was indeed one of the most learned and acute critics of any age,

but he was also Master of Trinity, Archdeacon of Bristol, held two livings besides, and enjoyed the honor of refusing the bishopric of Bristol, as not rich enough to tempt him. *Noblesse oblige:* that Bentley should hold a brief for the theological side was inevitable, and we need not be surprised when we hear him declaring, "We are sure, from the names of persons and places mentioned in Scripture before the Deluge, not to insist upon other arguments, that the Hebrew was the primitive language of mankind, and that it continued pure above three thousand years until the captivity into Babylon." The power of the theologic bias, when properly stimulated with ecclesiastical preferment, could hardly be more perfectly exemplified than in this captivity of such a man as Bentley.

At the beginning of the eighteenth century this sacred doctrine, based, as was supposed, upon explicit statements of Scripture, seemed forever settled. As we have seen, strong fortresses had been built for it in every Christian land; nothing seemed more unlikely than that the little groups of scholars scattered through these various countries could ever prevail against them. These strongholds were built so firmly, and had behind them so vast an army of religionists of every creed, that to conquer them seemed impossible. And yet at that very moment their doom was decreed. Within a few years from this period of their greatest triumph, the garrisons of all these sacred fortresses were in hopeless confusion, and the armies behind them in full retreat; a little later, both the orthodox fortresses and forces were in the hands of the scientific philologists.

How this came about will be shown in the second part of this chapter.*

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* The quotation from Guichard is from L'Harmonie étymologique des langues . . . dans laquelle par plusieurs Antiquités et Étymologies de toute sorte, je démonstre évidemment que toutes les langues sont descendues de l'Hébraique; par M. Estienne Guichard, Paris, 1631. The first edition appeared in 1606. For Willett, see his Hexapla, London, 1608, pp. 125–128. For the Address of L'Empereur, see his publication, Leyden, 1627. The quotation from Lightfoot, beginning, "Other commendations," etc., is taken from his Erubhin, or Miscellanies, edition of 1629. See also his works, vol. iv, pp. 46, 47, London, 1822. For Bishop Brian Walton, see the Cambridge edition of his works, 1828, Prolegomena, §§ 1 and 3. As to Walton's giving up the rabbinical points, he mentions in one of the latest editions of his work the fact that Isaac Casaubon, Joseph Scaliger, Isaac Vossius, Grotius, Beza, Luther, Zwingli, Brentz, Œcolampadius, Calvin, and even some of the popes, were with him in this. For Sennert, see his Dissertatio de Ebraicæ S. S. Linguæ Origine, etc., Wittenberg, 1657; also his Grammatica Orientalis, Wittenberg, 1666. For Buxtorf, see the preface to his Thesaurus Grammaticus Linguæ Sanctæ Hebreæ, sixth edition, 1663. For Gale, see his Court of the Gentiles, Oxford, 1672. For Morinus, see his Exercitationes de Lingua Primæva, Utrecht, 1694. For Thomassin, see his Glossarium Universale Hebraicum, Paris, 1697. For John Eliot's utterance, see Mather's Magnalia, Book III, p. 184. For Meric Casaubon, see his De Lingua Anglia Vet., p. 160, cited by Massey, p. 16 of Origin and Progress of Letters. For Bentley, see his works, London, 1836, vol. ii, p. 11,

# THE PEOPLING OF AMERICA.*

By M. ARMAND DE QUATREFAGES.

IN acknowledgment of the unexpected honor that has been done me in calling me to this chair, I have first to perform the very pleasant duty of saluting the foreign and French scholars who have responded to the invitation of our committee. I shall do it in few words, but I affirm, in the name of all my colleagues, that they come from the heart. Welcome, gentlemen!

Unluckily, the same honor imposes on me another task, and a difficult one. It is the usage, in opening a session of the Congress, for the president to make an address to his colleagues respecting the questions that are to occupy them; and what can I say, concerning America, to learned men who make that continent the object of their habitual studies? I do not merit, as you do, the title of Americanist. Called by the duties of my teacher's office to deal with the history of all human populations, I can not undertake especially a study which is more than sufficient to absorb a whole lifetime. I have much to learn from you, and I thank you in advance for all that you are going to teach me.

Yet, it is hardly necessary to say, in looking from the point of view of the whole, which has usually been my practice, my thought could not fail to be often directed to that New World the discovery of which opened so many new horizons to nearly all the branches of human knowledge. The question of the origin of its inhabitants appears at the very head of the problems which it sets before the anthropologist. Are the indigenous Americans in any degree relatives of the populations of the other continents? Or, have they appeared on the lands where we have found them, without any ethnological connection with those populations?

You know that both of these opinions have been maintained, and still have their partisans; and I made known long ago the solution which I had reached. In my view, America was origi-

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and citations by Welsford, Mithridates Minor, p. 2. As to Bentley's position as a scholar, see the famous estimate in Macaulay's Essays. For a short but very interesting account of him, see Mark Pattison's article in vol. iii of the last edition of the Encyclopædia Britannica. The position of Pattison as an agnostic dignitary in the English Church eminently fitted him to understand Bentley's career, both as regards the orthodox and the scholastic world. For perhaps the most full and striking account of the manner in which Bentley lorded it in the scholastic world of his time, see Marks's Life of Bentley, vol. ii, chap. xvii, and especially his contemptuous reply to the judges, as given in vol. ii, pp. 211, 212.

* Address before the eighth meeting of the Congress of Americanists.

nally, and has always been, peopled by migrations from the Old World. At the risk of repeating myself, I will briefly sum up the grounds of my conviction.

Permit me first to recall the two rules which I have constantly followed in the solution of the questions, sometimes so ardently contested, which the history of man raises. The first is to put away absolutely every consideration borrowed from dogma or philosophy, and to invoke only science—that is, experiment and observation. The second is, never to isolate man from other organized beings; and to admit that he is subject, as to all that is not exclusively human, to all the general laws which control equally animals and plants. Hence, we can not regard as true any doctrine or opinion which makes man an exception among organized beings.

We make the application of these principles to the question which occupies us, but in a broader way; for it is only a special case of a more general problem which we may formulate in the terms—Man is everywhere now: did he appear everywhere in the beginning? If not absolutely cosmopolitan in its origin, did the race appear at an indefinite number of points? Or, rather, born at a single and limited spot, has it gradually taken possession of the whole earth by migration? At first thought we might suppose that the answer to these questions would be very different according as we admit the existence of one or many human species. That would be a mistake. We purpose to show that polygenists can shake hands with monogenists on this point, without involving themselves in any contradiction. We take, first, the monogenist view.

Physiology, which leads us to recognize the unity of the human race, teaches us nothing in reference to its primary geographical origin. It is otherwise with the science which concerns the distribution of animals and plants over the surface of the globe. The geography of organic beings has also its general facts, which we call laws. These facts—these laws—must be learned and interrogated in order to solve the problem of the manner in which the globe was peopled. The first result of this inquiry is a demonstration that real cosmopolitanism, as we attribute it to man, does not exist anywhere, either in the animal or the vegetable kingdom. I cite a few of the evidences in support of this affirmation.

Take, first, what De Candolle says, that "no phanerogamous plant extends over the whole surface of the earth. There hardly exist more than eighteen the areas of which reach over half the lands; and there is no tree or shrub among the plants of most considerable extension." The last remark touches an order of considerations on which I shall insist further on.

In my lectures on this subject I have cited textually the words of the best authorities among men of science respecting the principal groups of fresh and salt water animals; I have passed in review the fauna of the air, beginning with insects; and have dwelt to some extent on fishes and reptiles. I will spare you the enumeration, and will speak of the bird the area of whose habitat is most extended. The peregrine falcon occupies all the temperate and warm regions of the Old and New Worlds, but does not reach the arctic regions, or Polynesia.

In his body, man is anatomically and physiologically a mammal—no more and no less. This class, therefore, interests us more than the others, and furnishes us with more precise knowledge. I will, for that reason, enter more into detail respecting it, taking as my guide the great work of Andrew Murray.

By virtue of their strength, their enormous locomotive powers, and of the continuity of the seas which they inhabit, the cetaceans should seem to be able to play a truly cosmopolitan part. They do not. Each species is cantoned within an area of greater or less extent, beyond which a few individuals may occasionally make excursions, but always to return soon within their bounds. Two exceptions to this general rule have been noted. A rorqual with large flippers, and a northern *Balænopterus*, natives of temperate and frigid seas, are said to have been found, the first at the Cape, the second at Java. Judging from what Van Beneden and Gervais, the two greatest authorities in cetology, say, these statements are at least doubtful. But, if we accept them as true, it is still the fact that neither species has been met in the seas that wash America and Polynesia. We find nothing else resembling the whales in cosmopolitism, even though it be narrow. Here, also, I spare you the details. You know as well as I do that the species of marsupials, edentates, and pachyderms have their respective countries clearly defined; and that, if the horse and hog are now in America, it is because they have been imported there by Europeans.

A very small number of ruminants inhabit the north of both continents. It is generally agreed to regard the reindeer and the caribou as only races of the same species; Brandt, with some reservations, says as much of the bison and the aurochs, the argali and the big-horn. But none of these species are found in the warm regions of these two quarters, or in all Oceania.

The carnivorous order perhaps offers some similar facts to the preceding. But when we come to the Cheiroptera and the Quadrumana, we do not find a single species common to both continents, or to the rest of the world.

Thus there is not a cosmopolite, after the manner of man, among all organized beings, whether plants or animals. Now, it is

evident that the area of the actual habitat of any animal or vegetable species includes the center where that species first appeared. By virtue of the law of expansion, the center should likewise be less in extent than the actual area. No plant and no animal, therefore, originated in all the regions of the globe. To suppose that man appeared in the beginning everywhere that we now see him would be to make a unique exception of him. The hypothesis can not, therefore, be received; and every monogenist must repel the conception of the initial cosmopolitism of the human species as false.

The same conclusion is imposed on polygenists, unless they refuse to apply to man the laws of botanical and zoölogical geography that govern all other beings. In fact, however much they have multiplied species of man—whether they assume that there are two, with Virey; fifteen, with Bery Saint-Vincent; or an undetermined but considerable number, with Gliddon—they have always united them into a single genus. A human genus can be no more cosmopolitan than a human species. Speaking of plants, De Candolle says, "The same causes have borne on genera and on species"; and this is as true of animals as of plants. Limiting ourselves to the animals—among the cetaceans, Murray thinks that the genera of the rorqual and the dolphin are represented in all the seas; Van Beneden and Gervais dispute this; we will, however, admit it, for it will not weaken our conclusions. Besides the cetaceans, there can be no question of generic cosmopolitism. Of the ruminants, the genera of the deer, the ox, etc.; of the carnivores, the cat, dog, bear, etc., have representatives in both worlds, but not in Australia or Polynesia. Further, as we examine the higher and higher groups, we see the number of these genera of large area diminishing. Finally, not a single genus of monkey is known to be common to the old and the new continents; and the simian type itself is wanting in the greater part of both worlds and Oceania.

Thus, whether we regard species or genera, the area of the habitat is the more restricted as the animals are more highly placed in the zoölogical scale. It is the same with plants. De Candolle says on this point, "The mean area of species is as much smaller as the class to which they belong has a more complete, more developed, or, in other words, more perfect organization."

Progressive cantonment, in proportion to the increasing perfection of the organisms, is then a general fact, a law, which is applicable to all organized beings, and which physiology easily accounts for. Now, this law disagrees absolutely with the hypothesis that there can exist a human race, comprehending several distinct species, which have appeared everywhere that we see

men. This is easily comprehended. Invoking the authority of Murray, and the universality of habitat which he attributes to the genera of the rorqual and the dolphin, polygenists might be tempted to say: "Non-cosmopolitism already presents two exceptions; why may there not be a third? Two genera of cetaceans are naturally represented in all the seas; why may not the human genus have appeared at the start in every land?"

This reasoning fails at the base. The rorquals and the dolphins belong to the lowest order of mammalia. Men, if we regard the body alone, are the highest order. Unless we constitute them a single exception, they must obey the laws of the superior group; consequently, they can not escape the law of progressive cantonment. It follows, hence, that a human genus, as the polygenists understand it, must have occupied in its origin an area no more extended than that which has devolved on some genera of monkeys. But, among the monkeys themselves, all naturalists recognize a hierarchy; all place at their head the order of the anthropoid apes. It is, then, from the secondary groups of this family that polygenists should ask for indications of the possible extent of the area primarily accorded to the human genus; and you know how inconsiderable is the area of the genera gibbon, orang, gorilla, and chimpanzee. You see that, at whatever point of view we place ourselves, we have either to assume that man alone escapes the laws that have regulated the geographical distribution of all other organized beings, or to admit that the primitive tribes were cantoned upon a very restricted space. By judging from present conditions, by making the largest concessions, by neglecting the incontestable superiority of the human type over the simian type, all that the polygenist hypothesis permits is to regard that area as having been nearly equivalent to that occupied by the different species of gibbons, which range, on the continent, from Assam to Malacca; in the islands, from the Philippines to Java. Monogenism, of course, tends to restrict this area still more, and to make it equal at most to that of the chimpanzee, which extends nearly from Cairo to the Senegal. I am the first to recognize that we may perhaps have to enlarge these limits at some later time. I consider the existence of tertiary man to be demonstrated; and only the geographical distribution of the monkeys, his contemporaries, can furnish more precise information upon the primary extension of the center of man's appearance. Paleontology has taught us that the area formerly occupied by the simian type was evidently more considerable than it is now. It may have been the same with the anthropoid apes. But, till this time, no fossil is connected with that family. You know that the *Dryopithecus*, which was long regarded as belonging to them, has been shown by the examina-

tion of the best preserved specimens to be nothing more than a monkey of an inferior order.

At any rate, the general laws of the geographical distribution of beings, and especially that of progressive cantonment, permit us to affirm that man primarily occupied only a very limited part of the globe; and that, if he is now everywhere, it is because he has covered the whole earth with his emigrant tribes.

I know that this thought of the peopling of the globe by migrations troubles many minds. It puts us in the face of an immense unknown; it raises a world of questions, a large number of which may appear to be inaccessible to our research. Thus, I have often been asked: "Why create all these difficulties? It is much more natural to confine ourselves to the popular movements attested by history, and accept autochthonism, especially in the case of the lowest savages. How could the Hottentots and the Fuegians reach their present countries, starting from some undetermined point which you place in the north of Asia? Such voyages are impossible; these peoples were born at the Cape of Good Hope and Cape Horn."

To these conclusions, if not received, I will first answer by an anecdote borrowed from Livingstone, the bearing of which is easy to comprehend. The illustrious traveler tells how in his youth he used to make with his brothers long excursions devoted to natural history. "In one of these exploring tours," he says, "we went into a limestone quarry, long before the study of geology had become as common as it has since. It is impossible to express with what joy and astonishment I set myself to picking out the shells which we found in the carboniferous rock. A quarryman looked at me with that air of compassion which a kindly man takes on at the sight of a person of unsound mind. I asked him how the shells came in the rocks. He answered, 'When God created the rocks, he made the shells and put them there.'" Livingstone adds: "What pains geologists might have spared themselves by adopting the Ottoman philosophy of that workman!" I will ask, in turn, Where would geology have been if men of science had adopted that philosophy? I ask the anthropologists to imitate the geologists; I invite them to inquire how and by what way the most distant peoples have radiated from the center of the first appearance of man to the extremities of the globe. I am not afraid to predict brilliant discoveries to those who will set themselves seriously to the study of numerous well-marked migrations. In this the past permits a glimpse into the future.

Some years ago, when they talked to me in such language as I have just repeated, they did not fail to add Polynesia to the list of regions which men destitute of all our perfected arts could not reach. You know how completely such assertions have been

refuted. Adding his personal researches to those of his predecessors, Hale first drew up the map of Polynesian migrations. Twenty years afterward I was able to complete the work of the learned American by the aid of documents collected after the appearance of that, the fundamental study. Now, as has been said by our lamented Gaussin, so competent for all that relates to Oceania, the peopling of Polynesia by migrations starting from the Indian Archipelago is as clearly demonstrated as the invasion of Europe by barbarians in the middle ages.

Like Polynesia, America was peopled by colonists from the Old World. Their point of departure is to be found and their tracks are to be followed. The labor will indeed be more difficult and longer upon the continent than in Oceania, principally because the migrations were more numerous and go back to a higher antiquity. The first Indonesian pioneers, who, departing from the island of Bouro, landed in the Samoan and Tongan Archipelagoes, probably made the passage toward the end of the fifth century, or near the time of the conversion of Clovis. The peopling of New Zealand by emigrants from the Manaias goes back, at most, to the earlier years of the fifteenth century. Thus, the peopling of Polynesia was all accomplished during our middle ages, while the first migrations to America date from geological times.

Two investigators to whom we owe some valuable discoveries, MM. Ameghino and Whitney, have traced the existence of American man back to the Tertiary age. But this opinion, as you know, has been contested by men of equal repute, and I believe that the view of the latter is confirmed by the comparison of the fossil faunas of the pampas, Brazil, and the Californian gravels. Hence, judging by the little that we know, man reached Lombardy and the Cantal when he had not yet penetrated to America. It is undoubtedly necessary at this point to make the most formal reserves with reference to the future; but, if the fact is confirmed, it seems to me to admit of easy explanation. Everything leads me to think that America and Asia were separated previous to the Quaternary age as they are now. Had it been otherwise, the species of mammalia common to the north of both continents would surely have been more numerous. The men and the land animals of the shores of Bering's Sea would have been stopped there. But when the great geological winter rapidly brought in a polar temperature in place of a mild climate like that of our California, the ancient Tertiary tribes were forced to migrate in every direction. A certain number of them embarked upon the bridge of ice which the cold had cast between the two shores, and arrived in America with the reindeer, as their Western congeners arrived in France with the same animal.

From that moment the era of migrations to America was opened. It has never been closed since. Every year the winter rebuilds the bridge which connects East Cape with Cape Prince of Wales; every year a road, comparatively easy for hardy pedestrians, stretches from one continent to the other; and we know that the coast populations of the opposite shores take advantage of it to maintain relations.

Is it not evident that, whenever one of those great movements which we know have agitated Asia made its shocks felt away in distant countries, whenever political or social revolutions overwhelmed them, fugitive or conquered people would have taken this route, of the existence of which they were aware? To get rid of the idea of migrations over the frozen sea, we should have to assume that all the corresponding regions have enjoyed a perpetual peace from the beginning of Quaternary times; but such a peace, you know, is not of this world.

This sea can have been only the principal route followed by the American immigrations. Farther south, the chain formed by the Aleutian Islands and Alaska opens a second route to tribes which have a little skill in navigation. The Aleuts occupy, in Dall's ethnological chart, the whole extremity of the peninsula. By these ways may have taken place what we might call the normal peopling of America. But, bathed on either side by a great ocean, that continent could not fail to profit by the chances of navigation; and we perceive more and more how this must have been the case. We are now justified in saying that Europe and Africa on one side, and Asia and Oceania on the other, have sent to America a number of involuntary colonists, more considerable, probably, than one would be ready to suppose.

The immigrations, in America as in Europe, have been intermittent, and separated sometimes by centuries. America has been peopled as if by a great human river, which, rising in Asia, has traversed the continent from north to south, receiving along its course a few small tributaries. This river resembles the torrent streams of which we have examples in France. Usually, and occasionally for years at a time, their bed is nearly dry. Then some great storm comes, and a liquid avalanche descends from the mountains where their sources lie, covers and ravages the plain, turning over the ancient alluviums, stirring up and mixing the old and new materials, and carrying farther each time the *débris* it has torn up on its passage. Like this has been the career of our ethnological river. Its floods have, besides, often been diverted to the right or left, and it has opened new derivations. It has also had its eddies. But its general direction has not changed, and we can trace it down to the present.

One of the highest tasks of Americanists will be to ascend to

the sources of this river; to determine the succession of its freshets; to define the origin and nature of the elements which they have brought down; to follow these elements from stage to stage, and thus discover the road which each of them has followed to its landing-place—in other words, to construct the history of the migrations of the different American peoples.

The accomplishment of this task will, as I have already said, present other and more difficulties in America than in Polynesia. Those who approach it will have recourse to nothing like the historical charts and the genealogies of which are composed the oral archives religiously preserved in all the islands of the Pacific. But modern science has resources of which we are gaining better and better comprehension of the power. Joining the data furnished by the study of the strata and their fossils, by comparative craniology, linguistics, and ethnography, we can enter on the mass of problems and foresee their solution. Serious efforts have been already made in this direction, and they have not been unfruitful. From this time we shall be able to indicate on the map a considerable number of itineraries, but they are so far partial and local. They are as yet no more than fragments, like those which Hale's predecessors could point to in Oceania.

The time may be long in coming, but let not Americanists lose heart. Every new discovery, of however little importance it may seem at first, will bring them nearer to the end. From year to year these fragments, now isolated and scattered, will join and be co-ordinated with one another; and some day the map of American migrations will be delineated, from Asia to Greenland and Cape Horn, as the map of Polynesian migrations has been drawn, from the Indian Archipelago to Easter Island, and from New Zealand to the Sandwich Islands.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

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According to M. J. Roche, the telephone was fore-fancied by Charles Bourseul, who said, in 1854: "Imagine that one can speak at a mobile plate so flexible as to lose none of the vibrations produced by the voice, and that this plate in succession establishes and interrupts the communication in an electric pile, and that you have another plate at a distance to execute the same vibrations at exactly the same times. . . . I believe it is certain that, in a more or less distant future, speech will in some such way as this be transmitted to a distance by electricity."

The theory of the European origin of the Aryan race is supported by Canon Isaac Taylor in his book on the origin of the Aryans. Inquiring which of the many races speaking the Aryan languages is the one in which the Aryan form of speech may be presumed to have originated, he numbers four such. They are the Iberians; the race represented by the Swedes and North Germans; the Ligurians, including the Auvergnats and the French Basques; and the Celto Slavic race. As among these, he decides upon the Celto-Slavs as the nearest to the primitive Aryan stock.

# THE DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

## II. IRON MILLS AND PUDDLING-FURNACES.

By WILLIAM F. DURFEE, Engineer.

IN these days of steam-engines, railways, and steam navigation —telegraphs, telephones, and electric lights—it is hard to understand a civilization which in literature and the fine arts has not been surpassed, yet had none of the above-named essentials of modern fast living and rapid work, and which possessed no better methods of manufacturing iron than those already described.

It will be evident to the most superficial observer that these methods were not calculated to produce merchantable bar iron either rapidly or cheaply, and this fact would be the more manifest as the bars or rods decreased in size. Therefore, as the requirements of trade were mainly for bars and rods of moderate dimensions, from which to forge nails, draw wire, and manufacture multitudes of the smaller articles of hardware for which the settlement of new countries had created a growing demand, nothing could have been more natural than that the efforts of mankind to meet the requirements of the time should have resulted in the invention of the "slitting-mill." We have no precise information as to the date of this invention, and none whatever respecting its inventor. It is very probable that the slitting-mill was invented in Sweden, and carried thence into Germany, Belgium, and England, whence it found its way to the colony of Massachusetts Bay, where the first "slitting-mill" used in America was put in operation some time prior to 1731. Swedenborg, in his De Ferro (1734), speaks of "slitting-mills" in Sweden, Germany, Belgium, and England, but does not refer to their origin, and says nothing whatever of grooved rolls. Slitting-mills were introduced into England as early as 1697.

A "slitting-mill" comprises two principal mechanisms, which are well illustrated by Fig. 17, which, together with Figs. 16 and 18, we have taken from Recueil de Planches sur les Sciences et les Arts. Paris, 1765. In Fig. 17 will be seen—

1. A pair of plain cylindrical rolls, C D, placed the one above the other, each receiving motion, independent of the other, from a water-wheel, there being one on each side of the mill, whose shafts are seen at E and O. These rolls could be adjusted so that the distance between their adjacent surfaces might be varied within certain limits. These rolls equalized the thickness of the rough forged bar and prepared it for the next operation.

2. The "slitting-mill" proper, seen between the letters N and

V′. This consisted of two horizontal shafts, placed in the same vertical plane with the axes of the rolls D C, and coupled to them by spindles *y* Y′, and coupling boxes *u u′* and V V′. On these shafts were fixed disks of steel, called "*cutters*," of a thickness equal to the width of the bar or rod desired; the edges of the

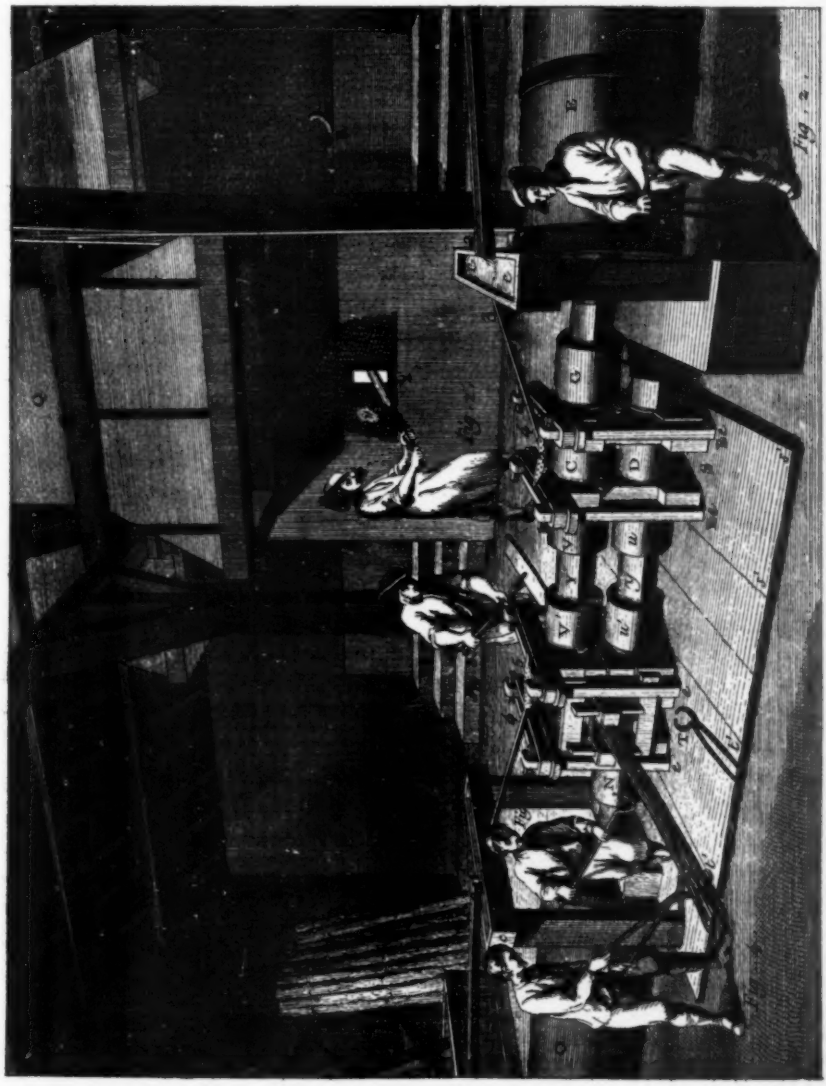

FIG. 17.—INTERIOR OF AN EARLY SLITTING-MILL. (1764.)

"cutters" on each shaft entered closely between those on the other, thus acting with reference to each other like the blades of rotary shears, which in fact they were; and, if the end of a flat bar of hot iron was thrust against the approaching edges of the rotary cutters, it would be immediately drawn between them,

and in its passage it was "sheared" or "slit" (hence the name "slitting-mill") into a number of bars or rods of the same width as the thickness of the cutters in use at the time. The shafts carrying the cutters could be taken from the frames or "housings" in which they revolved, and the cutters could be removed and replaced by others thicker or thinner as desired. The slitting-mill in Fig. 17 gets its motion from the same water-wheel shafts, E O, that drive the rolls C D.

John Houghton, in his Husbandry and Trade Improved, printed in 1697, speaks of rolling and slitting mills as "late improvements";* speaking of the operation of "slitting" iron bars that have been hammered out in a "blomary," he says: "They are put into a furnace to be heated red-hot to a good height, and then brought singly to the rollers, by which they are drawn even, and to a greater length; after this another workman takes them while hot, and puts them through the *cutters*, which are of divers sizes, and may be put on or off according to pleasure. Then another lays them straight, also while hot, and when cold binds them also into fagots, and then they are fit for sale."

By comparing this description of John Houghton's with Fig. 17, the original of which was published sixty-eight years later, it will be evident that very little change had taken place in the construction of slitting-mills in that period.

The furnace (whose door is seen at Y, in Fig. 17), in which the rough-hammered bars from the "blomary" were heated preparatory to rolling, was peculiarly constructed, and had fire-boxes, P R, on each end. Sections of this furnace are shown in Fig. 18; No. 1 being a longitudinal vertical section through the fire-boxes, P R, and the reverberatory heating-chamber Q; No. 2 a vertical transverse section of the heating-chamber Q, the chimney *q q*, and its hood *q*. It will be observed that the chimney of this furnace is not placed, as in a modern iron heating-furnace, at one end of the heating-chamber, while the fire-box is at the other; but that it is located outside and in a measure detached from the body of the furnace, and that the products of the combustion of the wood (which was the only fuel used) burned

* The earliest publication known to me, in which the use of "rolls" for drawing and shaping metals is described, was written by Giovanni Branca. In his work, Le Machine (published at Rome in 1629), he gives a very curious illustration of a rolling-mill, which, notwithstanding its manifest absurdity, suffices to show that he understood the action of the "rolls" and their advantages. The next mention of the use of rolls for giving shape to metals passed between them is contained in a work by Vittorio Zonca, published at Padua in 1656. In this work Zonca gives an engraving and description of a mill for rolling the double grooved fillets of lead which were used for securing the glass in stained windows. We regret that our limited space prevents us from reproducing these illustrations, neither of which has ever been referred to in any history of the manufacture of metals.

in the two fire-boxes P R, after traversing the heating-chamber Q, could only reach the chimney by passing out of the door Y. This arrangement was not calculated to produce a very rapid combustion of the fuel, and therefore large fire-boxes were necessary. The dimensions of this furnace would not be thought small even at the present time, for the heating-chamber Q was ten and a half feet long and seven feet wide, and the two fire-boxes were each four feet square.

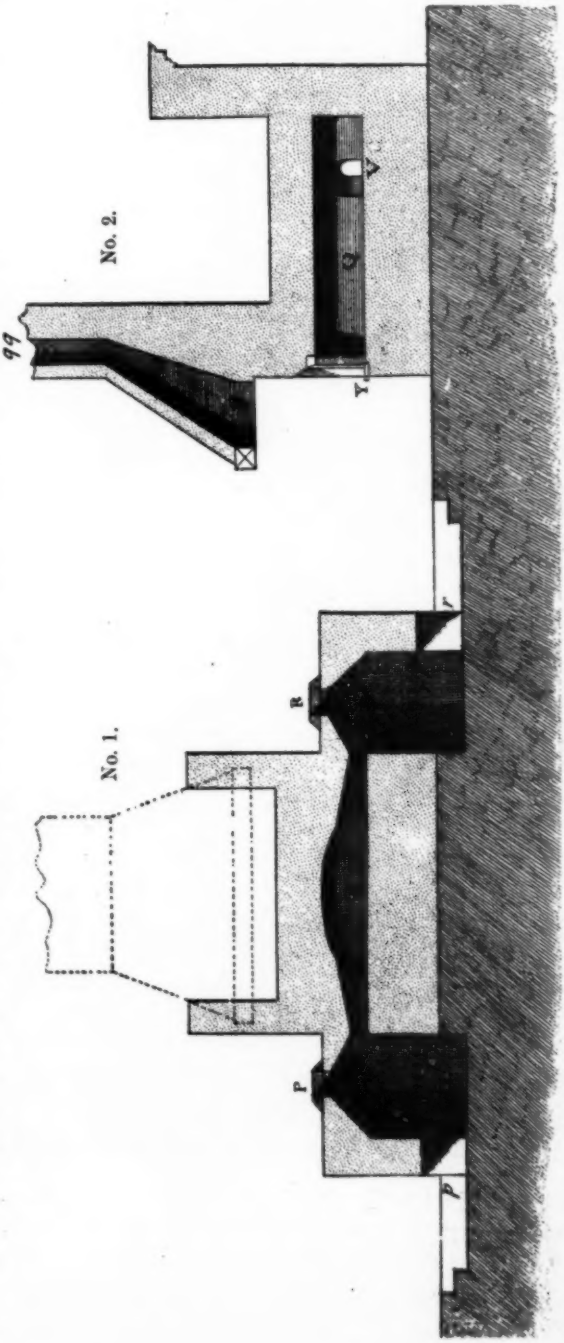


FIG. 18.—LONGITUDINAL AND TRANSVERSE SECTIONS OF HEATING FURNACE IN A SLITTING-MILL. (1764.)

The above construction of slitting-mills was not the initial form; for in that, the axes of the rolls and cutters, instead of being in the same, were in parallel planes, and instead of being driven directly from the water-wheels, there was interposed between the water-wheel shafts and those of the rolls and cutters some clumsy wooden gearing. Fig. 19 (from Swedenborg) shows a

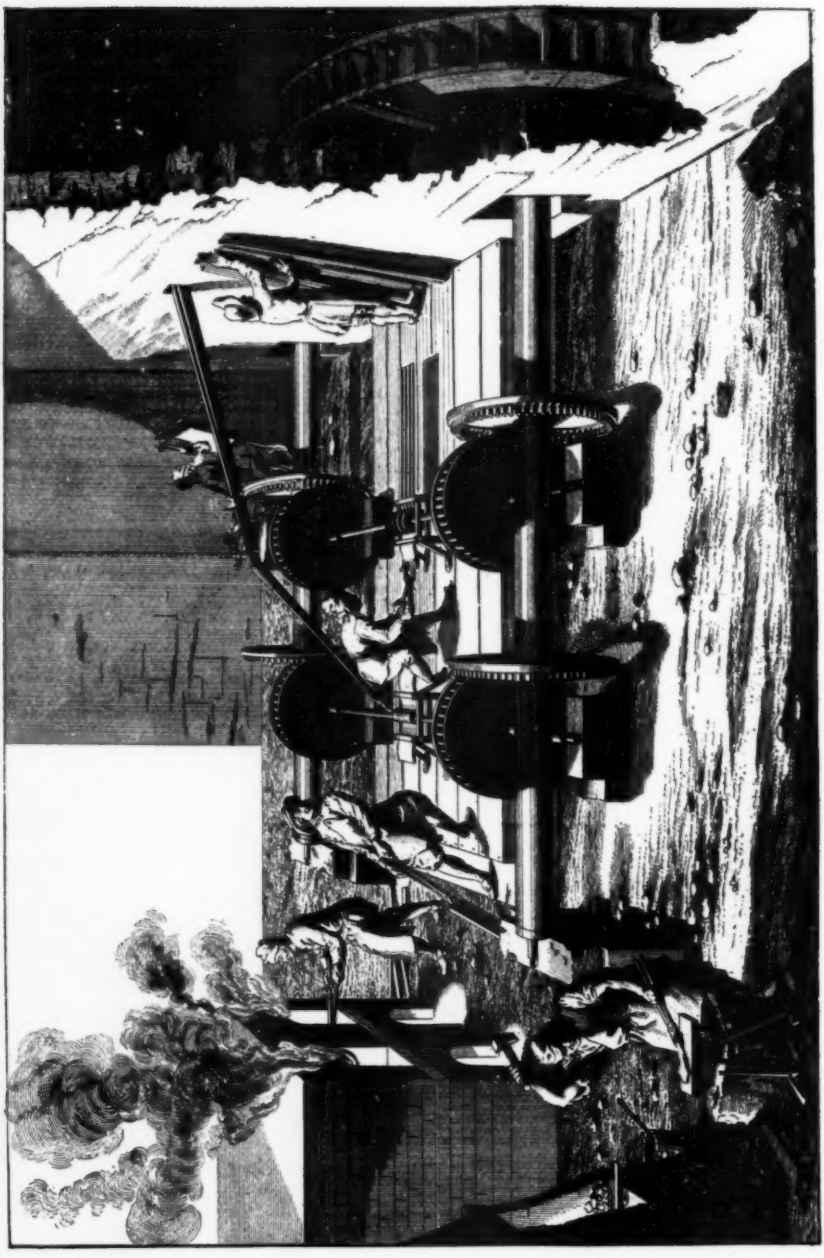

FIG. 19.—OLD FORM OF SLITTING-MILL IN USE IN SWEDEN IN 1734.

mill of this kind. It will be noted that the top roll and set of cutters were driven from one water-wheel, and the bottom roll and cutters from another; it will also be observed that the iron was evidently heated directly upon the coal. Swedenborg says: "In the vicinity of Liége are a few works in which iron is rolled

out and cut into small rods; and in Germany and England there is similar machinery, constructed as shown in Fig. 19, which vividly represents the whole operation.

"The furnace shown is simply constructed, and is divided into two parts, beneath each of which is an ash-pit. The iron is thrown into the furnace upon the mineral coal (*carbones fossiles*) and the bars are placed across one another obliquely, so that the flame and heat will have access to all sides of them. The roof of the furnace is formed into an arch. When the pieces of iron are heated by the direct action of the coal, and by the heat reverberated from the roof of the furnace, they are removed and run through two steel rolls."

By comparing this mill and furnace with those illustrated in Figs. 17 and 18, it will be evident that in the thirty-one years which intervened between the publication of De Ferro and Recueil de Planches sur les Sciences et les Arts important progress had been made in the construction of both mills and furnaces.

We have been thus particular in explaining the construction of the early European slitting-mills because it is certain that many of the ideas embodied in the first American slitting-mill were derived therefrom.

Industrial history is indebted to William H. Harrison, of Braintree, Mass., for the preservation of a record of the details of construction of certainly one of the earliest, if not actually the first, rolling and slitting mills built in America.* The general plan and elevation of the machinery, as also of the furnace employed in this mill, are shown in Fig. 20, and it will be noted that the natural tendency of the American mechanician to improve on what had already been accomplished asserted itself in this case. The designer while retaining many features of previous mills—such as wooden gearing, the use of two under-shot water-wheels, one of which drove the top set of cutters and the bottom roll, while the other drove the bottom set of cutters and the top roll—yet made some important improvements in the rolls by increasing their length and making offsets in them † by which iron of varying thickness could be made without changing their adjustment; and he also "chilled" one end of the rolls.‡ The furnace was a marked improvement over any before described, and was quite similar in idea to many in use at the present day; it had a "fire-box" (in which "*pine sticks*" were used as fuel), a "heating-chamber," and a "chimney." This mill was erected "at Middle-

* The First Rolling-Mill in America. A Paper read by William H. Harrison, M. E., at the Hartford Meeting of the American Society of Mechanical Engineers, May 4, 1881.

† A very close approximation to the "grooved roll."

‡ This is believed to be, if not the first "chilled roll" made, yet the first mentioned in rolling-mill construction.

boro, Mass., for Peter Oliver, one of the crown Judges in the province, and a brother of Andrew Oliver, the Lieutenant-Governor, in the year 1751."

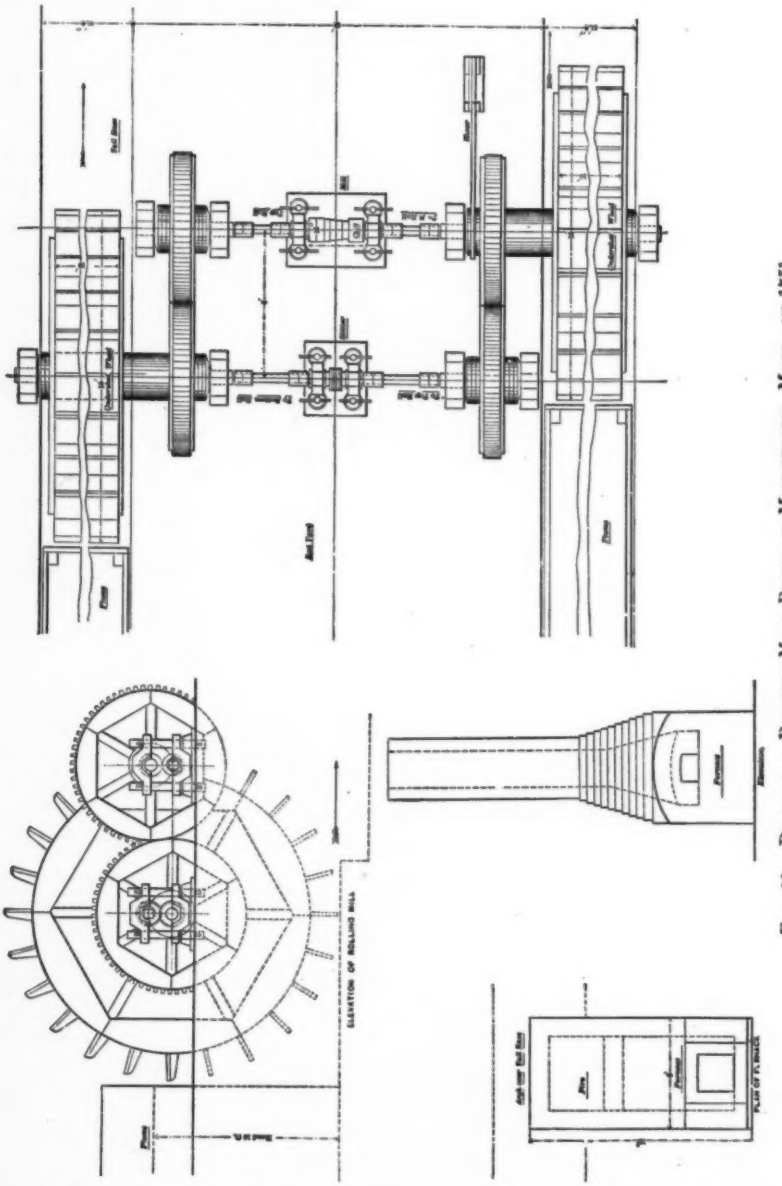

FIG. 20.—PLAN OF A ROLLING-MILL BUILT AT MIDDLEBORO, MASS., IN 1751.

Mr. Harrison says, in concluding his very interesting paper: "The drawing was made under the supervision of S. Wilder, Esq., of New Castle, Pa., a retired iron manufacturer, who worked in this mill in 1818, and gave the writer the principal dimensions and

the method of operating. As to whether this mill—in the year 1818—was precisely the one built in 1751, Mr. Wilder states that it is likely there had been some renewals of the wood-work, but most of the iron-work was the original. It was impossible to break down the mill, from the fact that, if a heavy piece or a pair of tongs were passed in, the effect would be—after some squeaking of the timber-wheels—to stop everything."

The claim made that this rolling-mill was the first in America can not be substantiated, for, according to the evidence adduced, it was not erected until 1751; but it is certain that there were already several slitting-mills in operation in the colonies, as is proved by the certificates transmitted to the Commissioners for Trade and Plantations by the Governors, Lieutenant-Governors, or commanders-in-chief of his Majesty's colonies in America, in pursuance of an act of the twenty-third of his present Majesty's [George II, 1750] reign, containing accounts of any mill or engine for slitting or rolling of iron, and any plating-forge to work with a tilt-hammer, and any furnace for making steel, erected in any of his Majesty's colonies in America":

| | Mill or engine for slitting or rolling iron. | Plating forge to work with a tilt-hammer. | Furnace for making steel. |
|---|---|---|---|
| Maryland | ..... | 1, with two tilt-hammers. | ..... |
| Pennsylvania | 1 | 1 | 2 |
| New Jersey | 1, not now in use. | 1, not now in use. | 1, not now in use. |
| New York | ..... | 1 " " | ..... |
| Connecticut | ..... | 1, 1, 1, 1, 1, 1 | 1 |
| Massachusetts Bay | 1, 1 | 1 | 1 * |

By these certificates of 1750 it appears that in all the colonies there were four slitting-mills, two of which were in Massachusetts; and as Judge Peter Oliver's mill was not erected (" by special privilege") until 1751, it could not have been one of them, and for the same reason it is certain that it was not the first rolling-mill in America. Nevertheless the paper of Mr. Harrison is instructive and valuable, inasmuch as it gives us the only reliable technical information we have relative to the construction and operation of rolling and slitting mills in colonial times. In addition to the leading constructive features of this mill, we are given some facts regarding its administration, and are told that " about eight men were employed, at about one dollar per day; six heats, of about eight hundred pounds each, were made in twelve hours' running. One pint of rum was consumed for each heat, or more, according to the weather. The value of the forge iron was one hundred dollars per ton; nail-rods, one

* A Comprehensive History of the Iron Trade throughout the World, from the Earliest Records to the Present Period. By Harry Scrivenor. London, 1841.

hundred and twenty dollars; and nails, twelve and a half cents or ninepence per pound. The nail-rods were put up in bundles of fifty-six pounds, and the nailers, who had their little shops around in the country, were expected to bring back fifty pounds of headed and pointed nails, receiving "store-pay" of calico, tea, rum, etc.

From this account it appears that "rum," in quantity proportioned "to the weather," was regarded as a necessary stimulant, to be furnished the workmen to enable them to properly perform their work. This custom, which was in fact universal in New England at the time, seems to have had the sanction of several generations, for the New Haven colonial records tell us that "a proposition made in May, 1662, 'in y^e^ behalfe of Capt. Clarke, that wine and liquors drawn at the iron workes might be custome free,' was allowed to the extent of one butt of wine and one barrel of liquors, and no more."

The act of 1750 was pretty generally enforced in the colonies, and the further erection of rolling and slitting mills prevented. James Hamilton, Lieutenant-Governor and Commander-in-Chief of the Province of Pennsylvania, and William Franklin (son of Benjamin Franklin), who was the royal Governor of the Province of New Jersey (1762 to 1776), were especially zealous in enforcing this act. Hon. Edward D. Halsey, in his History of Morris County, tells us that "a slitting-mill was erected at Old Boonton, on the Rockaway River, about a mile below the present town of Boonton, in defiance of the law, by Samuel Ogden, of Newark. The entrance was from the hill-side, and in the upper room first entered there were stones for grinding grain, the slitting-mill being below and out of sight. It is said that Governor William Franklin visited the place suddenly, having heard a rumor of its existence, but was so hospitably entertained by Mr. Ogden, and the iron-works were so effectually concealed, that the Governor came away saying that he was glad to find that it was a groundless report, as he had always supposed."

From the passage of the act of 1750 to the Revolution the iron industry of America was chiefly confined to the manufacture of pig and bar iron in the furnaces, forges, and mills already erected, and of castings from the blast-furnaces.

Israel Acrelius (who visited America in 1750–1756), in his History of New Sweden, when describing the iron-works of Pennsylvania, says: "The workmen are partly English and partly Irish, with some few Germans, though the work is carried on after the English method. The pig iron is smelted into 'geese' (*gäsar*), and is cast from five to six feet long and a half foot broad, for convenience of forging, which is in the Walloon style. The pigs are first operated upon by the finers (smelters). Then the chiffery, or hammer-men, take it back again into their hands and

beat out the long bars. The finers are paid 30*s.* a ton, the hammer-men 23*s.* 9*d.* per ton—that is to say, both together, £2 13*s.* 9*d.* The laborers are generally composed partly of negroes (slaves), partly of servants from Germany or Ireland bought for a term of years. . . . For four months in summer, when the heat is the most oppressive, all labor is suspended at the furnaces and forges."

About 1732 Colonel Spotswood erected some air-furnaces at a place called Massaponux, in Virginia, and used them " to melt his sow iron, in order to cast it into sundry utensils, such as backs for chimneys, andirons, fenders, plates for hearths, pots, mortars, rollers for gardeners, skillets, boxes for cart-wheels, and many other things. And, being cast from the sow iron, are much better than those which come from England, which are cast immediately from the ore for the most part. . . . Here are two of these air-furnaces in one room, that so in case one want repair the other may work, they being exactly of the same structure." It is said that in 1760 about six hundred tons of iron were smelted in Spotswood's furnaces, most of which was sent to England.

About 1750 Baron Henry William Stiegel came to Pennsylvania from Germany, " with good recommendations and a great deal of money." Soon after he purchased a tract of land in Lancaster County and laid out the town of Manheim; here he built a furnace, and named it after his wife, Elizabeth; some time afterward he built another furnace at Schaefferstown, Lebanon County, and it was here that he cast stoves (made of six plates of iron), which were among the first made in the country. The baron fully appreciated the value of advertising, and on each of the stoves he cast the following couplet:

"Baron Stiegel ist der Mann,
Der die Ofen machen kann"—

which signifies, "Baron Stiegel is the man who knows how to make stoves"; but, notwithstanding his skill and enterprise, he failed in his business. This result was due in a great degree to the difficulty of making prompt collections, and to the general stagnation of business due to the political complications with the mother-country. Elizabeth Furnace finally came into the possession of Robert Coleman, who cast shot, shells, and cannon for the Continental army. Some of the credits in his account with the Government are decidedly interesting. On November 16, 1782, appears the following entry: " By cash, being the value of 42 German prisoners of war, at £30 each, £1,260," and on June 14, 1783: " By cash, being the value of 28 German prisoners of war, at £30 each, £840."

During the Revolutionary War the manufacture of iron made little technological progress. Such establishments as possessed

the requisite skill cast cannon and mortars, and the iron ammunition for the same, for that army which controlled them for the time being. One of the most notable events connected with the manufacture of iron during these years was the making of the great iron chain which in 1778 was stretched across the Hudson River at West Point to prevent the passage of British vessels. Lossing, in his Field Book of the Revolution, gives a very interesting account of this work, of which we can quote only the leading facts. "The iron of which this chain was constructed was wrought from ore of equal parts from the Sterling and Long mines in Orange County. The chain was manufactured by Peter Townsend, of Chester, at the Sterling Iron Works in the same county, which were situated about twenty-five miles back of West Point. The chain was completed about the middle of April, 1778, and on the 1st of May it was stretched across the river and secured. It was fixed to huge blocks on each shore, and under cover of batteries on both sides of the river." "It is buoyed up," says Dr. Thacher, writing in 1780, "by very large logs of about sixteen feet long, pointed at the ends, to lessen their opposition to the force of the current at flood and ebb tide. The logs are placed at short distances from each other, the chain carried over them, and made fast to each by staples. There are also a number of anchors dropped at proper distances, with cables made fast to the chain to give it greater stability." The total weight of this chain was one hundred and eighty tons. Mr. Lossing visited West Point in 1848, and saw a portion of this famous chain, and he tells us that "there are twelve links, two clevises, and a portion of a link remaining. The links are made of iron bars, two and a half inches square, and average in length a little over two feet, and weigh about one hundred pounds each."

The manufacture of nails was one of the household industries of New England during a large part of the eighteenth century. James M. Swank, in Iron in All Ages, quotes from Nehemiah Bennet's description of the Town of Middleborough, Plymouth County, Massachusetts (1793): "Nailing, or the business of making nails, is carried on largely in the winters, by farmers and young men, who have little other business at that season of the year." Speaking of the early attempts to manufacture tacks, the same authority gives the following from the Furniture and Trade Journal: "In the queer-shaped, homely farm-houses, or the little contracted shops of certain New England villages, the industrious and frugal descendants of the Pilgrims toiled providently through the long winter months at beating into shape the little nails which play so useful a part in modern industry. A small anvil served to beat the wire or strip of iron into shape and point it; a vise worked by the foot clutched it

between jaws furnished with a gauge to regulate the length, leaving a certain portion projecting, which, when beaten flat by a hammer, formed the head. By this process a man might make, toilsomely, perhaps two thousand tacks per day." Arnold, in his History of the State of Rhode Island, claims that "the first cold-cut nail in the world was made in 1777 by Jeremiah Wilkinson, of Cumberland, R. I., who died in 1832, at the advanced age of ninety years." Bishop, speaking of Wilkinson's tacks, says: "They were first cut by a pair of shears (still preserved) from an old chest-lock, and afterwards headed in a smith's vise. Sheet iron was afterwards used, and the process extended to small nails, which he appears to have been one of the first to attempt. They were cut from old Spanish hoops, and headed in a clamp or vise by hand. Pins and needles were made by the same person during the Revolution from wire drawn by himself." Such was the genesis of the manufacture of nails in America; an industry now of the first importance, and which in 1889, after the lapse of little more than a century, produced over *eight hundred million pounds* of iron, steel, and wire nails, representing a consumption of this absolutely indispensable manufacture, for the past year, at the rate of over *twelve pounds* for each individual inhabitant of the United States. As nails enter as a component factor into all structures for domestic, manufacturing, and trade uses, this enormous consumption may be taken as a fair index of the development of the country during the past hundred years.

The adoption of the Constitution in 1787, followed by the enactment of the first national patent law in 1790 (previous to the establishment of a national government the several colonies had issued patents for meritorious inventions), powerfully stimulated the inventive genius of the people, and it soon became evident that America was destined to surpass all other nations in the invention and manufacture of labor-saving machinery.

One of the most important improvements in the manufacture of articles of metal, of which a large number were required of the same kind, was developed by Eli Whitney, the inventor of the cotton-gin, who, disappointed in his expectations relative to that machine, turned to the manufacture of small-arms for the United States Government. In 1798 he erected at Whitneyville, near New Haven, Conn., the first manufactory of fire-arms in which each part was made so exactly to the prescribed dimensions that it would fit its intended place in any one of thousands of muskets. Mr. Whitney not only conceived the ideas of the possibility and economic advantages of such perfect workmanship, but invented the system and much of the machinery by which it was practically accomplished. "Whitney's interchangeable system" has been applied successfully to the manufacture of

clocks and watches, sewing-machines and steam-engines, and is universally recognized as indispensable whenever accuracy and economy are to be combined with a large production.

Swank gives the following description of the Sterling Iron Works (already mentioned as the place where the West Point chain was forged), translated from a book published in Paris in 1801, written by the Marquis de Crevecœur, who was in the French service in the French and Indian War and afterward traveled extensively in this country:

"Hardly had we put our horses in the stable than Mr. Townsend, the proprietor, came to meet us with the politeness of a man of the world. Having learned that the object of our journey was to examine attentively his different works, he offered to show us all the details, and at once led us to his large furnace where the ore was melted and converted into pigs of sixty to one hundred pounds weight. The blast was supplied by two immense wooden blowers, neither iron nor leather being used in their construction. This furnace, he said, produced from two thousand to twenty-four hundred tons annually, three fourths of which are converted into bars, the rest melted into cannon and cannon-balls, etc. From there we went to see the forge. Six large hammers were occupied in forging bar iron and anchors and various pieces used on vessels. Lower down the stream (which afforded power to the works) was the foundry with its reverberatory furnace (air-furnace). Here he called our attention to several ingenious machines destined for different uses. The models he had sent him, and the machines he had cast from iron of a recently discovered ore, which, after two fusions, acquired great fineness; with it he could make the lightest and most delicate work. 'What a pity,' he said, 'that you did not come ten days sooner! I would have shown you, first, three new styles of plows, of which I have cast the largest pieces, and which, however, are no heavier than the old-fashioned. Each of them is provided with a kind of steelyard, so graduated that one can tell the power of the team and the resistance of the soil; second, I would have shown you a portable mill for separating the grain from the chaff; followed by another machine by which all the ears in the field can be easily gathered without being obliged to cut the stalk at the foot, according to the old method.' From the foundry we went to see the furnaces where the iron is converted into steel. 'It is not as good as the Swedes',' said Mr. Townsend, 'but we approach it—a few years more of experience and we will arrive at perfection. The iron which comes from under my hammers has had for a long time a high reputation, and sells for £28 to £30 per ton.' After having passed two days in examining these diverse works and admiring the skill with which they were supplied with water, as

well as the arrangements for furnishing the charcoal for the different furnaces, we parted from Mr. Townsend."

On June 27, 1810, Mr. Clemens Rentgen, of Pikeland, Chester County, Pennsylvania, obtained a patent for "rolling iron round, for ships' bolts, and other uses," by the following method: "This machine consists of two large iron rollers, fixed in a strong frame. Each roller has concavities turned in them, meeting each other to form perfectly round bolts, of from half an inch to one and three quarter inches, or any other size, in diameter, through which rollers the iron is drawn from the mouth of the furnace with great dispatch, and the iron is then manufactured better and more even than it is possible to forge it out. The force applied to the end of these rollers is like that applied to mills."

Swank states that W. H. Wahl, Ph. D., Secretary of the Franklin Institute (who is a descendant of Mr. Rentgen), showed him the original patent, and informed him that Mr. Rentgen "rolled round iron as early as 1812 or 1813, some of which was for the Navy Department of the United States Government"; and he adds, "The fact that a patent was granted to him as late as June 27, 1810, for a machine to roll iron in round shapes, would seem to furnish conclusive proof that Cort's rolls * had not then been introduced into the United States." About the beginning of the present century the steam-engine (two or three steam-engines had been imported and used for draining mines prior to the Revolutionary War) as a motive power for driving mills and factories began to attract attention. The period of its introduction is worthy of mention, as it has played a very important part in the development of the iron and steel industries of this country.

According to Swank, "the first rolling-mill erected in the United States to 'puddle' iron, and roll it into bars, was built by Col. Isaac Meason, in 1816 and 1817, at Plumsock, on Redstone Creek, in Fayette County, Pennsylvania. Thomas C. Lewis was the chief engineer in the erection of the mill, and George Lewis, his brother, was the turner and roller. They were Welshmen. . . . The mill contained two 'puddling furnaces,' one 'heating furnace,' one 'refinery,' and one 'tilt-hammer.' Raw coal was used in the 'puddling' and 'heating furnaces,' and coke in the 'refinery.'"

In the early practice in this country the operation of "puddling," by which cast iron is converted into wrought iron, was usually preceded by a process called "refining," which was effected by means of an apparatus called a "refinery"—a vertical section of one of the latest and best forms of which is shown in Fig. 21.

* Cort's patent was taken out in 1783, but the evidence is sufficient and conclusive as to a somewhat extended knowledge and use of grooved rolls on the continent of Europe many years prior to that date.

It consisted of a basin or hearth, *b*, in which a fire of charcoal or coke was built, the fuel being carried above the level of the water-cooled *tuyères*, *g g*. On this mass of ignited fuel a charge of a ton or a ton and a half of pig iron was thrown, over which fuel was heaped, and the blast (which was regulated by the valves, *k k*) was then turned on. In about one hour and a half the pig iron was melted, and its upper surface as it lay in the hearth was exposed to the action of the blast (oftentimes in the larger refineries there were six *tuyères*, three on a side, but in some of the oldest refineries there was but one *tuyère*); this effected the oxidation and removal of considerable of the carbon, most of the silicon, and a portion of the sulphur, a large amount of "slag" being formed. About two hours after the commencement of the operation the metal was "tapped out" on to the "running-out bed," which was a shallow trough made of very thick castings; a section of which is shown at *n*. These castings were provided with flanges, which rested upon the sides, *o o*, of a box or channel, *p*, filled with water to cool the running-out bed, and promote the rapid solidification of the liquid refined iron; and as soon as this was accomplished the final cooling was hastened by a jet of water forcibly thrown upon the upper surface of the metal from a hose. This caused the "cinder" on this surface to separate in a great degree from the refined metal, which, when perfectly cool, was broken up into pieces of manageable size. The fracture of "refined metal" was white, inclined to

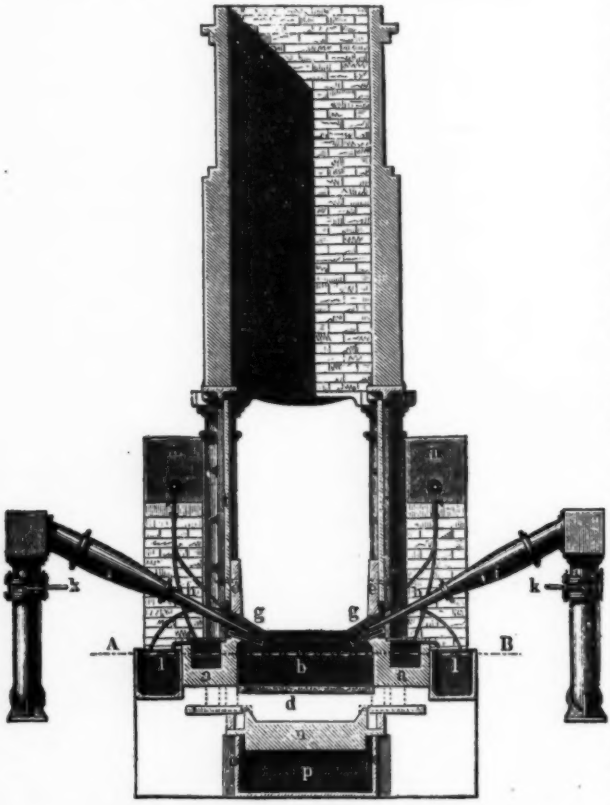


FIG. 21.—CROSS-SECTION OF A REFINERY.

a silvery luster, and oftentimes more or less porous or "honeycombed" near the upper surface, The purpose of this "refining" was, as the name suggests, the purification of the metal previous to its being treated in a puddling-furnace for final conversion into wrought iron. At the present day the "refinery" is rarely employed, improved methods having rendered it unnecessary.

The invention of the "puddling process" is usually ascribed to Henry Cort, of Gosport, England, who patented it in 1784. This process was a great improvement over that of the "blomary fire," inasmuch as the labor was diminished, and, as the metal was not in contact with the fuel, therefore raw mineral coal, which was much cheaper than charcoal, could be used with natural draught, thus dispensing with all blowing machinery. The process, as practiced on its introduction into America, consisted substantially of melting refined pig iron on the sand bottom of a reverberatory furnace, and stirring the pool (or "puddle," whence the name of the process) of molten metal until it became converted into a granular, pasty mass of wrought or forgeable iron, as the result of the decarbonizing action of the heated air passing through the furnace and over the metal. This granular mass of metal was divided by the "puddler" (as the workman was called) into several separate "balls," or "loups," which were taken in turn to a "shingling hammer," and "shingled" into "blooms"; this last operation being precisely similar to the shingling of the "ball" from a blomary fire, already described.

Figs. 22 and 23 are respectively vertical and horizontal longitudinal sections of one of the earlier forms of "puddling-furnace," in which *e* is the sand bed of the puddling-chamber, *d* the "bridge-wall" which separated the fuel on the grates *b* of the "fire-box" from the iron in the puddling-chamber *e*, *i* is the chimney-flue, and *k* a lever for raising the door *j*. In some of the early puddling-furnaces in New England and eastern Pennsylvania the fuel used was dry split wood; and as late as 1858 dry pine wood was used for puddling and heating at the Hurricane Rolling-Mill and Nail-Works in South Carolina. This was probably the last instance of the use of wood as a fuel for such purposes in the United States.

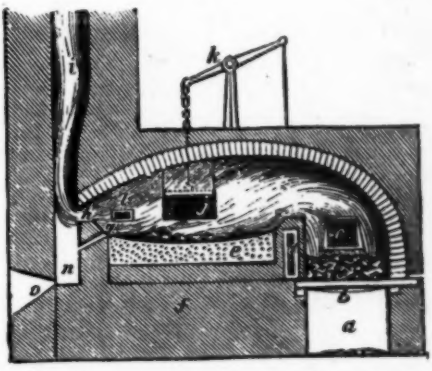


FIG. 22.—AN EARLY PUDDLING-FURNACE.

Soon after the introduction of the puddling process into this country, Mr. Samuel Baldwyn Rogers, of Nant-y-glo, Monmouth-

shire, England, made very important improvements in the construction of puddling-furnaces, by substituting iron plates for the original sand bottoms of their puddling-chambers; and in the conduct of the process, by using iron-ore as the chief source of the oxygen necessary to decarburize the melted pig iron. This ore was packed around the sides of the interior of the furnace, and the bottom plates were protected by a layer of oxide of iron. These improvements more than doubled the daily production from a furnace, and at the same time a superior quality of iron was made.

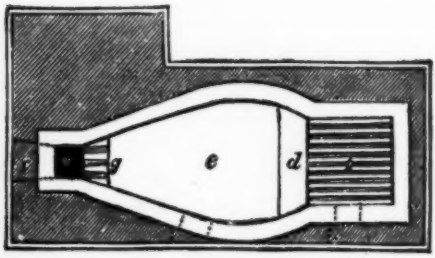


FIG. 23.—PLAN OF AN EARLY PUDDLING-FURNACE.

Mr. Rogers encountered a great deal of ridicule in attempting to introduce these improvements, which were pronounced impracticable and of no value by many of the leading iron-masters of England; and, as he failed to protect his rights by patents, the only reward that he ever received for inventions that have been of vast benefit to mankind was the nickname "Old Iron Bottoms," which was bestowed upon him by those of his contemporaries who fully believed that they had become possessed of all desirable knowledge, and were, in fact, too wise to learn. Unfortunately for our country, a few of the descendants of these wise fools, who were patriotic enough to "leave their country for their country's good," found their way to America, and are honoring their ancestry by sneering at all ideas and methods that are not hoary with antiquity and moldy respectability. In spite of such counsels in the past, the improvements of Mr. Rogers found their way into use in America and the world at large, and for the last fifty years there has not been a puddling-furnace as originally constructed by Cort in existence.

A very good idea of the appearance and construction of the puddling-furnace in common use in the "puddle-mills" of England and America is conveyed by Figs. 24 and 25. Fig. 24 is a side elevation of the furnace, whose interior form is shown by dotted lines. The whole of the brick-work is inclosed in a casing of cast-iron plates, securely bolted together. The door of the working-chamber is seen in the center (and at C, Fig. 25), counterbalanced and operated by a lever and chain, and below it the "tap-hole," by which the "cinder" made in the process is "tapped off"; to the left is seen the "stoke-hole," and just to the right of it is shown, in dotted lines, the outline of the "bridge-wall" separating the "fire-box" on the left from the "working-chamber" in

the center of the furnace. The chimney (shown at the right of the cut, broken in three places for convenience of illustration) is usually from thirty to forty feet in height, provided with a damper operated by a lever at its top, and its flue is usually eighteen inches square. Fig. 25 is a section of the furnace (on line G, H, Fig. 24), showing the form of its interior in plan, and the relative position of "fire-grate," "working-chamber," and "chimney-stack." In mills driven by steam power it is not now uncommon to place a horizontal cylindrical flue-boiler over each puddling and heating furnace, and generate the steam required to run the mill by passing the heat, that would otherwise go to waste up the chimney, underneath the boiler, and thence through the flues to the chimney-stack. This construction was the invention of the late John Griffen, who at the time of his death (January 14, 1884) was General Superintendent of the Phœnix Iron Company at Phœnixville, Pa. The idea of utilizing the waste heat of puddling and heating

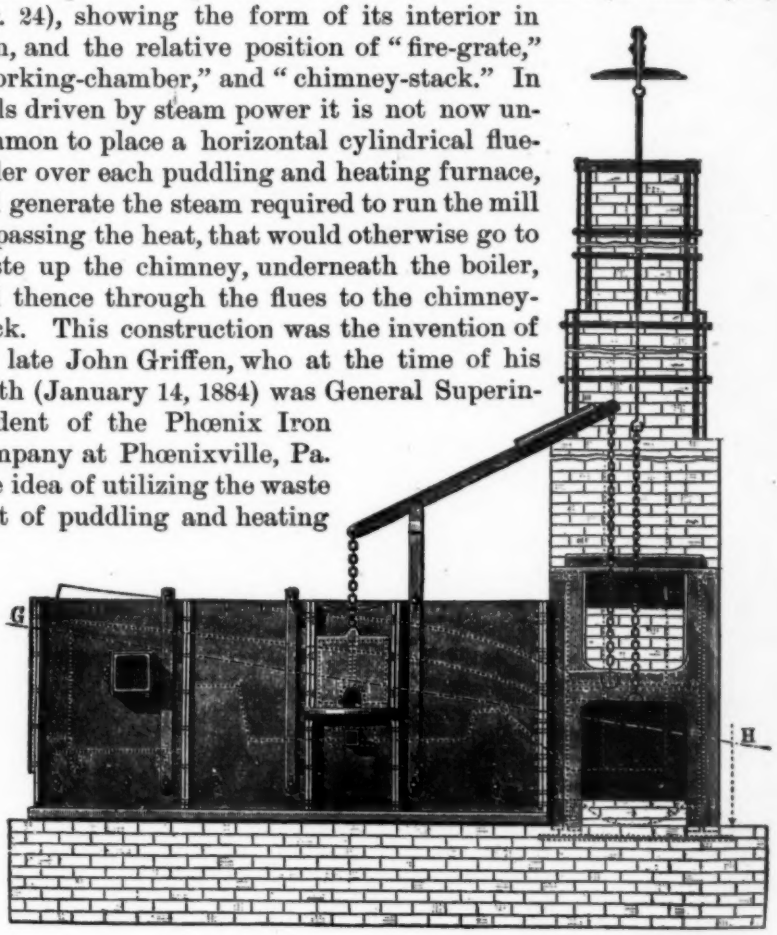


FIG. 24.—A MODERN PUDDLING-FURNACE.

furnaces for the making of steam was, however, quite old at the time he brought out his arrangement.

When, in 1846, Mr. Griffen erected at Norristown, Pa., for Messrs. Moore & Hooven, the first mill in which all the steam was generated in boilers placed over the furnaces, the wise fools were in strong force; and Swank tells us that "Mr. Griffen met with much opposition from observers while employed in constructing the mill upon this plan, and many predictions were made that the new arrangement would prove a failure. It was a great

innovation on the practice then prevailing, but it was a complete success." Whereat the wise fools who had been posing as "observers," promptly swallowed all their observations, and with the characteristic agility of their race turned each a back somerset,

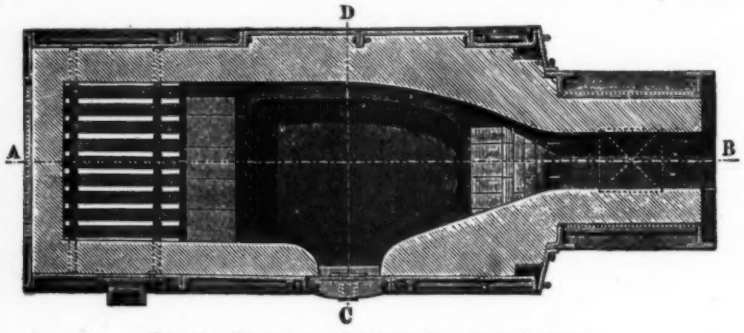


FIG. 25.—PLAN OF A MODERN PUDDLING-FURNACE.

and, coming up blandly smiling, with the remark "We always told you so," forthwith proceeded to foolishly praise that which they had more foolishly condemned.

The rapid increase of the manufacture of iron in consequence of the introduction of the puddling process naturally called for a

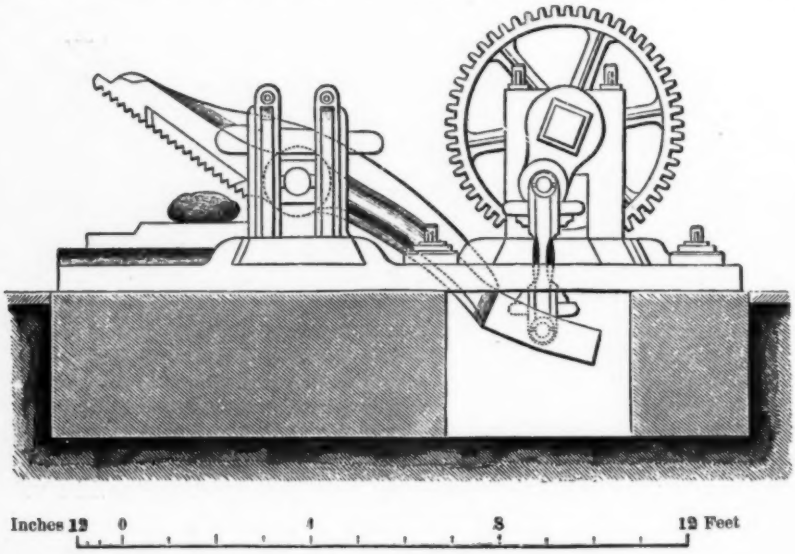


FIG. 26.—THE ALLIGATOR SQUEEZER.

more expeditious method than the blows of a "trip-hammer" for expelling the cinder from the "puddle-balls" and forming them into "blooms"; and this necessity resulted in the invention of the "alligator squeezer," which consisted (as shown in Fig. 26) of a lever whose long arm was operated by a crank, the short arm

being provided on its under side with a number of angular corrugations, so that it is somewhat suggestive of the jaw and teeth of an alligator. The "ball" from the puddling-furnace was placed between the upper and lower jaws of this squeezer, and the workmen turned it with tongs at each upward movement of the upper jaw (always moving it toward the fulcrum of the lever), thus causing the ball to be forcibly squeezed by each downward movement; and when the operation was completed the most of the liquid cinder had been expelled from the ball, which had assumed the form of a bloom.

Although this apparatus was of sufficient capacity for shingling a very much larger product than the trip-hammer which it displaced, yet it required the assistance of a workman, or "shingler," as he was called; and, as the number of puddling-furnaces increased in the mills, it soon became evident that more rapid and purely automatic machinery for shingling puddle-balls was desirable. This want was supplied by the inventive genius of Henry Burden, of Troy, N. Y., who in 1840 invented the "rotary squeezer." Fig. 27 is an elevation of the original form of this machine, and Fig. 28 is a horizontal section of Fig. 27 on line A B. The construction consisted substantially of a heavy cast-iron casing or "scroll," *a a* (Fig. 28), firmly attached to four surrounding columns, which stood upon a heavy bed-plate and also sustained a massive casting which formed the upper support and bearing of a vertical shaft to which the heavy cast-iron drum *b* (Fig. 28) was firmly attached; below the bed-plate is seen (in Fig. 27) the gearing for giving motion to the shaft and drum.

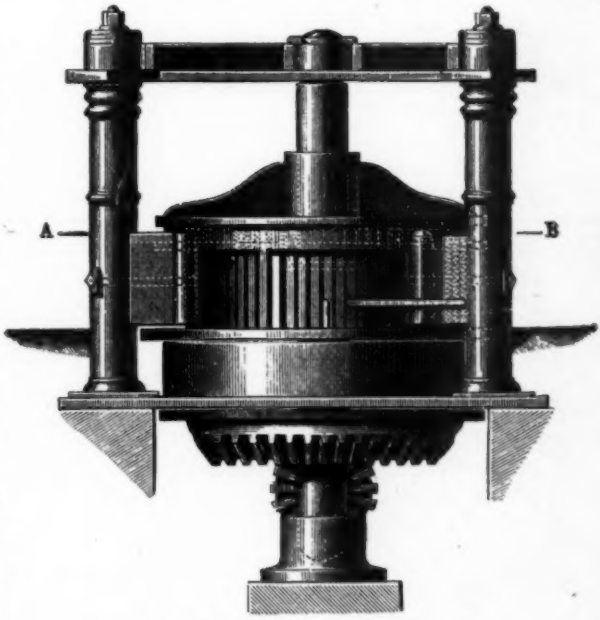


FIG. 27.—THE ROTARY SQUEEZER.

The "puddle-ball" was thrown into the machine at the place indicated by the arrow (Fig. 28), and, as the drum *b* revolved rap-

idly to the left, the ball was drawn in between it and the scroll, the teeth on each preventing its slipping; and, as it was carried around by the movement of the drum, the constantly narrowing space caused the ball to be subjected to great pressure, which expelled the liquid cinder and at the same time forced the ball to assume before it was ejected from the machine the form of a cylindrical bloom. In order that the squeezer should accommodate balls of considerable variation in weight, and at the same time exert a powerful end-pressure or "upsetting" during the operation of shingling, a very heavy ring of cast iron (shown in the plane A B, Fig. 27) was made to rest upon the upper end of the mass of metal as it passed through the machine; this ring was kept in position horizontally and guided in its movement vertically by the upper part of the spindle of the drum *b*. The finished "bloom" was discharged from the "squeezer" at the right-hand side of the opening in the "scroll" through which the "ball" originally entered, and such was the rapidity of the operation that the "bloom" retained sufficient heat at its close to permit of its being passed directly through the "rolls" and rolled into "billets" or "muck-bars" without reheating.

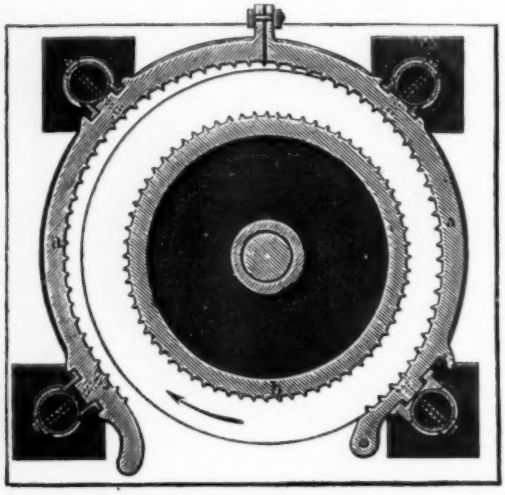

FIG. 28.—PLAN OF THE ROTARY SQUEEZER.

The modern form of the above-described machine differs somewhat from that shown in the illustrations in the arrangement of its driving-gear, but the general principles embodied in the original construction are still retained. Large numbers of "Burden Rotary Squeezers" are in use in the rolling-mills of the world, and it may fairly take rank as one of the most important improvements in the manufacture of iron that have had their origin in America.

Coincident with the improvements in apparatus and methods for producing wrought iron, the general advancement of all the arts, and especially those relating to the manufacture of machinery, created a demand for forgings of a size impossible of execution by the ancient trip and helve hammers; and as a means of supplying this need for uncommonly heavy forgings, the

manufacture of the "Nasmyth direct-acting steam hammer" was commenced in the year 1843, by Messrs. Merrick & Towne, at the Southwark Foundry, Philadelphia, Pa. The "Nasmyth hammer," as at first constructed at this establishment, is represented by Fig. 29, in which A A A are the two upright frames of cast iron, which supported a lintel, C, that sustained the steam-cylin-

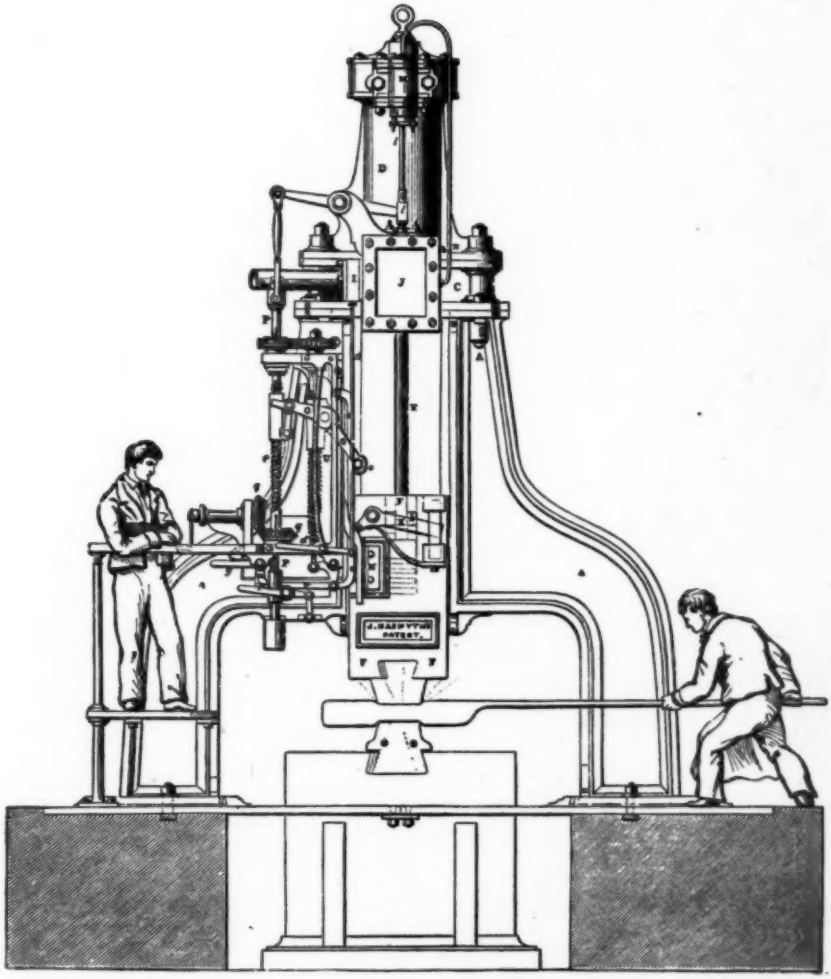

FIG. 29.—THE NASMYTH STEAM HAMMER.

der, D, and its steam-chest, J. The piston-rod, E, was secured at its lower end to the "hammer-block," F F F, which was free to move vertically between, and was guided by, the upright frames, A A A. The valve-gear is shown on the left-hand frame, A, which actuated the valve in the steam-chest, J. The intensity or working force of the blow delivered to the work upon the anvil

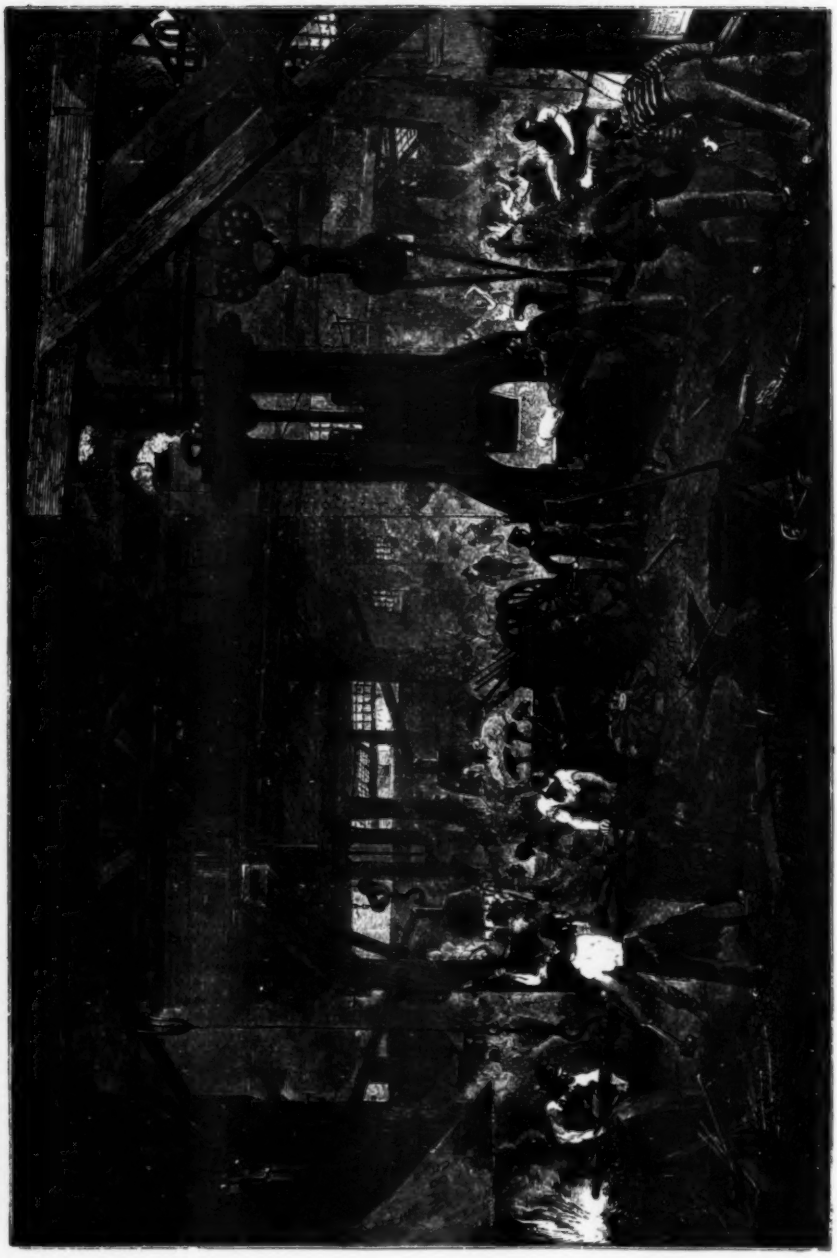

FIG. 30.—A MODERN FORGE.

varied with the height through which the "hammer-block" was allowed to fall, and this height could be regulated within the limits of the full stroke of the hammer by means of the valve-gear. As soon as the blow had been delivered, the mechanism for effecting the upward movement of the hammer-block came

into action. This consisted of a heavy lever, X, which had its fulcrum on the hammer-block, F F. The shorter arm of this lever rested in contact with a vertical bar connected with the valve-gear, P, in such a way that at whatever point of its length the bar chanced to receive a side pressure from the short arm of the lever, X, it caused the admission of steam to the lower end of the cylinder, D, thus causing the "hammer-block" to make its upward stroke. This occurred automatically the instant after the delivery of the blow; the inertia of the weighted end of the lever not being overcome, it moved downward after the "hammer-block" came to rest, and forced its short arm against the vertical bar in the manner described. Such, in brief, were the construction and operation of the first steam hammer built in America, and placed by its builders in the smith's shop of their Southwark Foundry, at Philadelphia, where (Mr. J. Vaughn Merrick writes me) it was "continuously employed till after the sale of the works in 1871."

The original invention of Nasmyth has undergone many changes, and since the expiration of his patents a multitude of modifications having for their object the improvement of its action or its adaptation to some particular variety of work have been brought forward; but they all involve the fundamental ideas of lifting a vertically guided heavy mass, or hammer-block, by the direct action of steam upon a piston with which it is connected, and letting it fall at pleasure upon the work in hand by cutting off the supply of steam and releasing that already beneath the piston; and this combination of ideas and methods originated with James Nasmyth, who, by his invention, augmented the strength of the arm of Vulcan and conferred new powers and possibilities upon the skill of man.

FIG. 30.—A MODERN FORGE.

The appearance of a modern forge and all its Vulcanian activities is well represented by Fig. 30, which to an experienced eye presents what may be called a scene of well-regulated confusion, in which, amid smoke and flame, coal and iron, the hissing of steam, beating of sledges, ringing of anvils, and the scorching glare of white-hot metal, the stalwart, half-naked sons of Vulcan strain and sweat at their appointed tasks, while the solid earth for miles around quakes under the ponderous blows of the Cyclopean hammer * that

> . . . upheaves its mighty arm
> While on the anvil turns the glowing mass—

* This is no exaggeration, as it has been authoritatively stated that the blows of the steam hammers in Woolwich Arsenal have been felt at Greenwich Observatory, about two miles distant.

and all make up a picture suggestive rather of the Inferno* or the wars of thunderbolt and tempest than an exemplification of the most important of the arts of peace.

[*To be continued.*]

## STAR-STREAMS AND NEBULÆ.

By GARRETT P. SERVISS.

IT is wonderful what a mass of evidence confirmatory of the nebular hypothesis in its broadest sense has been accumulated within the past few years. Most of this new testimony in favor of an old theory has been furnished by Astronomical Photography, that giant that sees the invisible, which has recently risen to the aid of astronomers with the startling suddenness and unexpectedness of the Arab fisherman's afrite escaping from the despised bottle. Perhaps the most notable of these celestial photographs, in the direct light that it throws upon the nebular hypothesis, is Mr. Roberts's already famous picture of the Andromeda nebula. Nobody can look upon the vast nebulous spirals that this photograph reveals, surrounding a great central condensation, and showing here and there a brighter knot where a satellite of the huge focal mass is in process of formation, without feeling that Laplace and Kant were not very far astray in their guess as to the mode of formation of the solar system.

But, although stars in abundance are scattered over and around the Andromeda nebula, there is little in their appearance to suggest a connection between them and the nebula. It is different with the nebulæ in the Pleiades and in Orion. In the wonderful photographs of the Pleiades by the Henry brothers of Paris one not only sees masses of nebulous matter clinging, so to speak, to some of the more conspicuous stars, but in one place a long, straight, narrow strip of nebula has stars dotted along its whole length, like diamonds strung upon a ribbon. It becomes more difficult to resist the conclusion that in this strange nebulous streak, with its starry file, we possess an indication of the mode

* I am reminded of a stalwart iron-master who formerly owned a forge in New England, and whose ideas of futurity, apparently, were not perfectly definite—at any rate, he was disposed to be somewhat inquisitive in his way in regard thereto. Whenever he could tempt a clergyman to visit his forge, he would place him immediately in front of the largest furnace, and, as the attendant on a signal raised the door, revealing a temperature within that Nebuchadnezzar's furnace could not have surpassed, he would howl in the ear of the scorched and thoroughly frightened preacher the inquiry, "Is HELL any hotter than *that?*" It has not been recorded that he ever obtained any positive information in answer to this question, the circumstances of which doubtless afforded food for thought to the parties to whom it was put.

of origin of the many curious streams and chains of stars with which the heavens abound, when we look at another amazing revelation of celestial photography. I refer to Prof. Pickering's photograph of Orion, taken with a portrait-lens from a mountain in southern California.

In this photograph a tremendous spiral nebula is revealed, covering a space on the sky fifteen degrees in diameter, and embracing the whole of the constellation with the exception of the head and shoulders and the upraised arms of the imaginary giant. The well-known nebula in the Sword, the three bright stars in the Belt, the brilliant first-magnitude star Rigel, together with its less splendid neighbor Beta of Eridanus, and Kappa Orionis, forming the lower left-hand corner of the great quadrilateral of Orion—are all included within the boundaries of this vast nebula. The nebula in the Sword is seen to be only an exceptionally bright condensation in the nebulous system surrounding it.

But for our purposes the thing to be particularly noticed is the arrangement of the stars within the nebula. Any one who has viewed Orion with a powerful opera or field glass must have been struck with the curious marshaling of many of the smaller stars. This is particularly noticeable around the Belt, where the star Epsilon, itself long known to be enmeshed in a faint nebula, is environed with a garland of little stars, which, defiling in a beautiful double curve, finally stop near Delta, the next star above in the Belt. But, indeed, one does not need a glass in order to perceive similar rows of stars in Orion. The most conspicuous of these, after the three stars in the Belt themselves, are those that outline the giant's left arm and the lion's skin that he is supposed to bear upon it. Another row, not so striking, is, however, more interesting just at this point, because it follows the curve of the great outer spiral of the newly discovered nebula. This file of stars really begins below the Belt at Eta, and, curving round between the Belt and Gamma or Bellatrix in the left shoulder, includes the stars 27, 22, $\psi^1$, $\psi^3$, 33, 38, and $\omega$, besides others too faint to be visible to the unassisted eye. The connection between these stars and the nebula seems too evident to be doubted. The spiral form of the latter furnishes an explanation

STAR GARLAND IN THE BELT OF ORION.

of the geometrical arrangement of the former. So with the chain of telescopic stars described above as winding around the bright stars in the Belt—the nebular forms account for the configuration of the stars.

In the cut of Orion's Belt, above, an attempt has been made to represent the appearance of the assemblage of small stars around Epsilon, the center star of the Belt. All the stars there shown can not be seen with an ordinary opera-glass, but a strong field-glass will reveal them and many more besides. In fact, with a powerful glass the complication of curving star-lines becomes rather confusing to one attempting to draw them, and the cut must be regarded rather as an "impressionist" picture than as one showing every star accurately in its place and of precisely the right magnitude. Still, it will be found an approximately correct representation. The reader should bear in mind the fact that the star Epsilon, the center of this remarkable sidereal array, has long been known to be surrounded by a strong nebulosity, and that in the photograph referred to this spot appears as one of the principal foci of the great spiral nebula. These considerations naturally lead to the conclusion (which has also been reached upon other grounds so far as the larger stars are concerned) that Epsilon and the other leading stars of Orion, with the exception of Betelgeuse, which lies beyond the boundaries of the nebula, are at practically the same distance from us as the small stars surrounding them, all being members of one system.

There are many such star-streams to be found in the sky where as yet no related nebulæ have been discovered. But one can hardly doubt, in view of the evidence which the photographs we have referred to furnish, that the forms of the streams are derived from the pre-existing forms of the parent nebulæ. In many cases, of course, the process of nebular condensation has been finished, and we can never expect to discover any evidence of the nebula having once existed beyond the peculiar configuration of the stars to which it gave birth. In other cases, as in this of Orion, photography may yet reveal to us the existence of faint nebulous spirals still connected with the star-groups. Prof. Holden's discovery of a starry ring connected with the celebrated ring nebula in Lyra is in direct accord with the revelations of photography in this respect. Another interesting example is furnished by Mr. W. F. Denning's discovery last September of a small nebula which is completely encircled by a ring of stars. It is impossible, when looking at Mr. Denning's sketch of this curious object in The Observatory, to think that the stars and the nebula there shown do not belong to a single system.

Among the most striking examples of curved or spiral stellar arrangement are the circlet of small stars surrounding Delta

Canis Majoris and the exceedingly beautiful star-curves in the neighborhood of Alpha Persei, both of which are figured in my Astronomy with an Opera-glass. No one can survey the heavens with any kind of an optical instrument for half an hour without discovering many similar instances. If it should ever be demonstrated that the individuals composing these star-rows have all an identical parallax, or, in other words, are all at the same distance from us, so much additional strength would be given to the argument that they owe their origin to a nebula which resembled in shape the figure that they mark out. But the inherent probability that the stars concerned in such cases really do have practically the same parallax is so great that actual measurement could hardly make it stronger.

Looking at the matter still more broadly, it is clear that the Milky Way itself may be regarded as the starry residuum of a far grander nebula even than that of Orion, which once completely encircled our heavens; while the origin of such stellar streams as we behold in Eridanus, Pisces, and other constellations having their stars comparatively widely separated and few in number, may be referred to smaller nebulous masses once scattered over the region of space included within and extending on each side of the plane of the galactic circle.

## THE ARYAN QUESTION AND PREHISTORIC MAN.

By Prof. T. H. HUXLEY.

THE rapid increase of natural knowledge, which is the chief characteristic of our age, is effected in various ways. The main army of science moves to the conquest of new worlds slowly and surely, nor ever cedes an inch of the territory gained. But the advance is covered and facilitated by the ceaseless activity of clouds of light troops provided with a weapon—always efficient, if not always an arm of precision—the scientific imagination. It is the business of these *enfants perdus* of science to make raids into the realm of ignorance wherever they see, or think they see, a chance; and cheerfully to accept defeat, or it may be annihilation, as the reward of error. Unfortunately, the public, which watches the progress of the campaign, too often mistakes a dashing incursion of the Uhlans for a forward movement of the main body; fondly imagining that the strategic movement to the rear, which occasionally follows, indicates a battle lost by science. And it must be confessed that the error is too often justified by the effects of the irrepressible tendency which men of science share with all other sorts of men known to me, to be impatient

of that most wholesome state of mind—suspended judgment; to assume the objective truth of speculations which, from the nature of the evidence in their favor, can have no claim to be more than working hypotheses.

The history of the "Aryan question" affords a striking illustration of these general remarks.

About a century ago, Sir William Jones pointed out the close alliance of the chief European languages with Sanskrit and its derivative dialects now spoken in India. Brilliant and laborious philologists, in long succession, enlarged and strengthened this position until the truth that Sanskrit, Zend, Armenian, Greek, Latin, Lithuanian, Slavonian, German, Celtic, and so on, stand to one another in the relation of descendants from a common stock became firmly established, and thenceforward formed part of the permanent acquisitions of science. Moreover, the term "Aryan" is very generally, if not universally, accepted as a name for the group of languages thus allied. Hence, when one speaks of "Aryan languages," no hypothetical assumptions are involved. It is a matter of fact that such languages exist, that they present certain substantial and formal relations, and that convention sanctions the name applied to them. But the close connection of these widely differentiated languages remains altogether inexplicable, unless it is admitted that they are modifications of an original relatively undifferentiated tongue; just as the intimate affinities of the Romance languages—French, Italian, Spanish, and the rest—would be incomprehensible if there were no Latin. The original or "primitive Aryan" tongue, thus postulated, unfortunately no longer exists. It is a hypothetical entity, which corresponds with the "primitive stock" of generic and higher groups among plants and animals; and the acknowledgment of its former existence, and of the process of evolution which has brought about the present state of things philological, is forced upon us by deductive reasoning of similar cogency to that employed about things biological.

Thus, the former existence of a body of relatively uniform dialects, which may be called primitive Aryan, may be added to the stock of definitely acquired truths. But it is obvious that, in the absence of writing or of phonographs, the existence of a language implies that of speakers. If there were primitive Aryan dialects, there must have been primitive Aryan people who used them; and these people must have resided somewhere or other on the earth's surface. Hence philology, without stepping beyond its legitimate bounds and keeping speculation within the limits of bare necessity, arrives, not only at the conceptions of Aryan languages and of a primitive Aryan language, but of a primitive Aryan people and of a primitive Aryan home, or country occupied by them.

But where was this home of the Aryans? When the labors of modern philologists began, Sanskrit was the most archaic of all the Aryan languages known to them. It appeared to present the qualifications required in the parental or primitive Aryan. Brilliant Uhlans made a charge at this opening. The scientific imagination seated the primitive Aryans in the valley of the Ganges; and showed, as in a vision, the successive columns, guided by enterprising Brahmans, which set out thence to people the regions of the Western world with Greeks and Celts and Germans. But the progress of philology itself sufficed to show that this Balaclava charge, however magnificent, was not profitable warfare. The internal evidence of the Vedas proved that their composers had not reached the Ganges. On the other hand, the comparison of Zend with Sanskrit left no alternative open to the assumption that these languages were modifications of an original Indo-Iranian tongue spoken by a people of whom the Aryans of India and those of Persia were offshoots, and who could therefore be hardly lodged elsewhere than on the frontiers of both Persia and India—that is to say, somewhere in the region which is at present known under the names of Turkistan, Afghanistan, and Kafiristan. Thus far, it can hardly be doubted that we are well within the ground of which science has taken enduring possession. But the Uhlans were not content to remain within the lines of this surely-won position. For some reason, which is not quite clear to me, they thought fit to restrict the home of the primitive Aryans to a particular part of the region in question; to lodge them amid the bleak heights of the long range of the Hindoo Koosh and on the inhospitable plateau of Pamir. From their hives in these secluded valleys and wind-swept wastes, successive swarms of Celts and Greco-Latins, Teutons and Slavs, were thrown off to settle, after long wanderings, in distant Europe. The Hindoo-Koosh-Pamir theory, once enunciated, gradually hardened into a sort of dogma; and there have not been wanting theorists who laid down the routes of the successive bands of emigrants with as much confidence as if they had access to the records of the office of a primitive Aryan quartermaster-general. It is really singular to observe the deference which has been shown, and is yet sometimes shown, to a speculation which can, at best, claim to be regarded as nothing better than a somewhat risky working hypothesis.

Forty years ago, the credit of the Hindoo-Koosh-Pamir theory had risen almost to that of an axiom. The first person to instill doubt of its value into my mind was the late Robert Gordon Latham, a man of great learning and singular originality, whose attacks upon the Hindoo-Kooshite doctrine could scarcely have failed as completely as they did, if his great powers had been bestowed upon making his books not only worthy of being read, but

readable. The impression left upon my mind, at that time, by various conversations about the "Sarmatian hypothesis," which my friend wished to subsitute for the Hindoo-Koosh-Pamir speculation, was that the one and the other rested pretty much upon a like foundation of guess-work. That there was no sufficient reason for planting the primitive Aryans in the Hindoo Koosh, or in Pamir, seemed plain enough; but that there was little better ground, on the evidence then adduced, for settling them in the region at present occupied by western Russia, or Podolia, appeared to me to be not less plain. The most I thought Latham proved was, that the Aryan people of Indo-Iranian speech were just as likely to have come from Europe, as the Aryan people of Greek, or Teutonic, or Celtic speech from Asia. Of late years, Latham's views, so long neglected, or mentioned merely as an example of insular eccentricity, have been taken up and advocated with much ability in Germany as well as in this country—principally by philologists. Indeed, the glory of Hindoo-Koosh-Pamir seems altogether to have departed. Prof. Max Müller, to whom Aryan philology owes so much, will not say more now, than that he holds by the conviction that the seat of the primitive Aryans was "somewhere in Asia." Dr. Schrader sums up in favor of European Russia; while Herr Penka would have us transplant the home of the primitive Aryans from Pamir in the far East to the Scandinavian Peninsula in the far West.

I must refer those who desire to acquaint themselves with the philological arguments on which these conclusions are based to the recently published works of Dr. Schrader and Canon Taylor;* and to Penka's Die Herkunft der Arier, which, in spite of the strong spice of the Uhlan which runs through it, I have found extremely well worth study. I do not pretend to be able to look at the Aryan question under any but the biological aspect; to which I now turn.

Any biologist who studies the history of the Aryan question, and, taking the philological facts on trust, regards it exclusively from the point of view of anthropology, will observe that, very early, the purely biological conception of "race" illegitimately mixed itself up with the ideas derived from pure philology. It is quite proper to speak of Aryan "people," because, as we have seen, the existence of the language implies that of a people who speak it; it might be equally permissible to call Latin people all those who speak Romance dialects. But, just as the application of the term Latin "race" to the divers people who speak Romance languages, at the present day, is none the less absurd be-

* Schrader, Prehistoric Antiquities of the Aryan Peoples. Translated by F. B. Jevons, M. A., 1890. Taylor, The Origin of the Aryans, 1890.

cause it is common; so it is quite possible that it may be equally wrong to call the people who spoke the primitive Aryan dialects and inhabited the primitive home, the Aryan race. "Aryan" is properly a term of classification used in philology. "Race" is the name of a subdivision of one of those groups of living things which are called "species" in the technical language of zoölogy and botany; and the term connotes the possession of characters distinct from those of the other members of the species, which have a strong tendency to appear in the progeny of all members of the races. Such race-characters may be either bodily or mental, though in practice, the latter, as less easy of observation and definition, can rarely be taken into account. Language is rooted half in the bodily and half in the mental nature of man. The vocal sounds which form the raw materials of language could not be produced without a peculiar conformation of the organs of speech; the enunciation of duly accented syllables would be impossible without the nicest co-ordination of the action of the muscles which move these organs; and such co-ordination depends on the mechanism of certain portions of the nervous system. It is therefore conceivable that the structure of this highly complex speaking apparatus should determine a man's linguistic potentiality; that is to say, should enable him to use a language of one class and not another. It is further conceivable that a particular linguistic potentiality should be inherited and become as good a race-mark as any other. As a matter of fact, it is not proved that the linguistic potentialities of all men are the same. It is affirmed, for example, that, in the United States, the enunciation and the timbre of the voice of an American-born negro, however thoroughly he may have learned English, can be readily distinguished from that of a white man. But, even admitting that differences may obtain among the various races of men, to this extent, I do not think that there is any good ground for the supposition that an infant of any race would be unable to learn, and to use with ease, the language of any other race of men among whom it might be brought up. History abundantly proves the transmission of languages from some races to others; and there is no evidence, that I know of, to show that any race is incapable of substituting a foreign idiom for its native tongue.

From these considerations it follows that community of language is no proof of unity of race, is not even presumptive evidence of racial identity.* All that it does prove is that, at some

* Canon Taylor (Origin of the Aryans, p. 31) states that "Cuno . . . was the first to insist on what is now looked on as an axiom in ethnology—that race is not coextensive with language," in a work published in 1871. I may be permitted to quote a passage from a lecture delivered on the 9th of January, 1870, which brought me into a great deal of trouble. "Physical, mental, and moral peculiarities go with blood and not with language.

time or other, free and prolonged intercourse has taken place between the speakers of the same language. Philology, therefore, while it may have a perfect right to postulate the existence of a primitive Aryan "people," has no business to substitute "race" for "people." The speakers of primitive Aryan may have been a mixture of two or more races, just as are the speakers of English and of French at the present time.

The older philological ethnologists felt the difficulty which arose out of their identification of linguistic with racial affinity, but were not dismayed by it. Strong in the prestige of their great discovery of the unity of the Aryan tongues, they were quite prepared to make the philological and the biological categories fit, by the exercise of a little pressure on that about which they knew less. And their judgment was often unconsciously warped by strong monogenistic proclivities, which at bottom, however respectable and philanthropic their origin, had nothing to do with science. So the patent fact that men of Aryan speech presented widely diverse racial characters was explained away by maintaining that the physical differentiation was post-Aryan; to put it broadly, that the Aryans in Hindoo-Koosh-Pamir were truly of one race; but that, while one colony, subjected to the sweltering heat of the Gangetic plains, had fined down and darkened into the Bengalee, another had bleached and shot up, under the cool and misty skies of the north, into the semblance of Pomeranian grenadiers; or of blue-eyed, fair-skinned, six-foot Scotch Highlanders. I do not know that any of the Uhlans who fought so vigorously under this flag are left now. I doubt if any one is prepared to say that he believes that the influence of external conditions, alone, accounts for the wide physical differences between Englishmen and Bengalese. So far as India is concerned, the internal evidence of the old literature sufficiently proves that the Aryan invaders were "white" men. It is hardly to be doubted that they intermixed with the dark Dravidian aborigines; and that the high-caste Hindoos are what they are in virtue of the Aryan blood which they have inherited,* and of the selective influence of their surroundings operating on the mixture.

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In the United States the negroes have spoken English for generations; but no one on that ground would call them Englishmen, or expect them to differ physically, mentally, or morally from other negroes." (Pall Mall Gazette, January 10, 1870.) But the "axiom in ethnology" had been implied, if not enunciated, before my time; for example, by Ecker in 1865.

* I am unable to discover good grounds for the severity of the criticism, in the name of "the anthropologists," with which Prof. Max Müller's assertion that the same blood runs in the veins of English soldiers "as in the veins of the dark Bengalese," and that there is "a legitimate relationship between Hindoo, Greek, and Teuton," has been visited. So far as I know anything about anthropology, I should say that these statements may be correct literally, and probably are so substantially. I do not know of any good reason for

The assumption that, as there must have been a primitive Aryan people, in the philological sense, so that people must have constituted a race in the biological sense, is pretty generally made in modern discussions of the Aryan problem. But whether the men of the primitive Aryan race were blonds or brunets, whether they had long or round heads, were tall or were short, are hotly debated questions, into the discussion of which considerations quite foreign to science are sometimes imported. The combination of swarthiness with stature above the average and a long skull, confer upon me the serene impartiality of a mongrel; and, having given this pledge of fair dealing, I proceed to state the case for the hypothesis I am inclined to adopt. In doing so, I am aware that I deliberately take the shilling of the recruiting sergeant of the Light Brigade, and I warn all and sundry that such is the case.

Looking at the discussions which have taken place from a purely anthropological point of view, the first point which has struck me is that the problem is far more complicated and difficult than many of the disputants appear to imagine; and the second, that the data upon which we have to go are grievously insufficient in extent and in precision. Our historical records cover such an infinitesimally small extent of the past life of humanity, that we obtain little help from them. Even so late as 1500 B. C., northern Eurasia lies in historical darkness, except for such glimmer of light as may be thrown here and there by the literature of Egypt and of Babylonia. Yet, at that time, it is probable that Sanskrit, Zend, and Greek, to say nothing of other Aryan tongues, had long been differentiated from primitive Aryan. Even a thousand years later, little enough accurate information is to be had about the racial characters of the European and Asiatic tribes known to the Greeks. We are thrown upon such resources as archæology and human paleontology have to offer, and, notwithstanding the remarkable progress made of late years, they are still meager. Nevertheless, it strikes me that, from the purely anthropological side, there is a good deal to be said in favor of the two propositions maintained by the new school of philologists: first, that the people who spoke "primitive Aryan" were a distinct and well-marked race of mankind; and, secondly, that the area of the distribution of this race, in primeval times, lay in Europe, rather than in Asia.

For the last two thousand years, at least, the southern half of Scandinavia and the opposite or southern shores of the Baltic have been occupied by a race of mankind possessed of very definite

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the physical differences between a high-caste Hindoo and a Dravidian, except the Aryan blood in the veins of the former; and the strength of the infusion is probably quite as great in some Hindoos as in some English soldiers.

characters. Typical specimens have tall and massive frames, fair complexions, blue eyes, and yellow or reddish hair—that is to say, they are pronounced blonds. Their skulls are long, in the sense that the breadth is usually less, often much less, than four fifths of the length, and they are usually tolerably high. But in this last respect they vary. Men of this blond, long-headed race abound from eastern Prussia to northern Belgium; they are met with in northern France and are common in some parts of our own islands. The people of Teutonic speech, Goths, Saxons, Alemanni, and Franks, who poured forth out of the regions bordering the North Sea and the Baltic, to the destruction of the Roman Empire, were men of this race; and the accounts of the ancient historians of the incursions of the Gauls into Italy and Greece, between the fifth and the second centuries B. C., leave little doubt that their hordes were largely, if not wholly, composed of similar men. The contents of numerous interments in southern Scandinavia prove that, as far back as archæology takes us into the so-called Neolithic age, the great majority of the inhabitants had the same stature and cranial peculiarities as at present, though their bony fabric bears marks of somewhat greater ruggedness and savagery. There is no evidence that the country was occupied by men before the advent of these tall, blond long-heads. But there is proof of the presence, along with the latter, of a small percentage of people with broad skulls—skulls, that is, the breadth of which is more, often very much more, than four fifths of the length.

At the present day, in whatever direction we travel inland from the continental area occupied by the blond long-heads, whether southwest, into central France; south, through the Walloon provinces of Belgium into eastern France; into Switzerland, south Germany, and the Tyrol; or southeast, into Poland and Russia; or north, into Finland and Lapland, broad-heads make their appearance, in force, among the long-heads. And, eventually, we find ourselves among people who are as regularly broad-headed as the Swedes and North Germans are long-headed. As a general rule, in France, Belgium, Switzerland, and south Germany, the increase in the proportion of broad skulls is accompanied by the appearance of a larger and larger proportion of men of brunet complexion and of a lower stature; until, in central France and thence eastward, through the Cevennes and the Alps of Dauphiny, Savoy, and Piedmont, to the western plains of north Italy, the *tall blond long-heads* * practically disappear, and are replaced by

* I may plead the precedent of the good English words "block-head" and "thick-head" for "broad-head" and "long-head," but I can not say that they are elegant. I might have employed the technical terms brachycephali and dolichocephali. But it can not be said that they are much more graceful; and, moreover, they are sometimes em-

*short brunet broad-heads.* The ordinary Savoyard may be described in terms the converse of those which apply to the ordinary Swede. He is short, swarthy, dark-eyed, dark-haired, and his skull is very broad. Between the two extreme types, the one seated on the shores of the North Sea and the Baltic, and the other on those of the Mediterranean, there are all sorts of intermediate forms, in which breadth of skull may be found in tall and in short blond men, and in tall brunet men.

There is much reason to believe that the brunet broad-heads, now met with in central France and in the west central European highlands, have inhabited the same region, not only throughout the historical period, but long before it commenced; and it is probable that their area of occupation was formerly more extensive. For, if we leave aside the comparatively late incursions of the Asiatic races, the center of eruption of the invaders of the southern moiety of Europe has been situated in the north and west. In the case of the Teutonic inroads upon the empire of Rome, it undoubtedly lay in the area now occupied by the blond long-heads; and, in that of the antecedent Gaulish invasions, the physical characters ascribed to the leading tribes point to the same conclusion. Whatever the causes which led to the breaking out of bounds of the blond long-heads, in mass, at particular epochs, the natural increase in numbers of a vigorous and fertile race must always have impelled them to press upon their neighbors, and thereby afford abundant occasions for intermixture. If, at any given prehistoric time, we suppose the lowlands verging on the Baltic and the North Sea to have been inhabited by pure blond long-heads, while the central highlands were occupied by pure brunet short-heads the two would certainly meet and intermix in course of time, in spite of the vast belt of dense forest which extended, almost uninterruptedly, from the Carpathians to the Ardennes; and the result would be such an irregular gradation of the one type into the other as we do, in fact, meet with.

On the southeast, east, and northeast, throughout what was once the kingdom of Poland, and in Finland, the preponderance of broad-heads goes along with a wide prevalence of blond complexion and of good stature. In the extreme north, on the other hand, marked broad-headedness is combined with low stature, swarthiness, and more or less strongly Mongolian features, in the

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ployed in senses different from that which I have given in the definition of broad-heads and long-heads. The *cephalic index* is a number which expresses the relation of the breadth to the length of a skull, taking the latter as 100. Therefore, "broad-heads" have the cephalic index above 80 and "long-heads" have it below 80. The physiological value of the difference is unknown; its morphological value depends upon the observed fact of the constancy of the occurrence of either long skulls or broad skulls among large bodies of mankind.

Lapps. And it is to be observed that this type prevails increasingly to the eastward, among the central Asiatic populations.

The population of the British Islands, at the present time, offers the two extremes of the tall blond and the short brunet types. The tall blond long-heads resemble those of the continent; but our short brunet race is long-headed. Brunet broad-heads, such as those met with in the central European highlands, do not exist among us. This absence of any considerable number of distinctly broad-headed people (say with the cephalic index above 81 or 82) in the modern population of the United Kingdom is the more remarkable, since the investigations of the late Dr. Thurnam, and others, proved the existence of a large proportion of, tall broad-heads among the people interred in British tumuli of the Neolithic age. It would seem that these broad-skulled immigrants have been absorbed by an older long-skulled population; just as, in south Germany, the long-headed Alemanni have been absorbed by the older broad-heads. The short brunet long-heads are not peculiar to our islands. On the contrary, they abound in western France and in Spain, while they predominate in Sardinia, Corsica, and south Italy, and, it may be, occupied a much larger area in ancient times.

Thus, in the area which has been under consideration, there are evidences of the existence of four races of men: (1) blond long-heads of tall stature, (2) brunet broad-heads of short stature, (3) Mongoloid brunet broad-heads of short stature, (4) brunet long-heads of short stature. The regions in which these races appear with least admixture are—(1) Scandinavia, north Germany, and parts of the British Islands; (2) central France, the central European highlands, and Piedmont; (3) arctic and eastern Europe, central Asia; (4) the western parts of the British Islands and of France; Spain, south Italy. And the inhabitants of the regions which lie between these foci present the intermediate gradations, such as short blond long-heads, and tall brunet short-heads and long-heads which might be expected to result from their intermixture. The evidence at present extant is consistent with the supposition that the blond long-heads, the brunet broad-heads, and the brunet long-heads have existed in Europe throughout historic times, and very far back into prehistoric times. There is no proof of any migration of Asiatics into Europe, west of the basin of the Dnieper, down to the time of Attila. On the contrary, the first great movements of the European population of which there is any conclusive evidence is that series of Gaulish invasions of the east and south, which ultimately extended from north Italy as far as Galatia in Asia Minor.

It is now time to consider the relations between the phenomena of racial distribution, as thus defined, and those of the distribu-

tion of languages. The blond long-heads of Europe speak, or have spoken, Lithuanian, Teutonic, or Celtic dialects, and they are not known to have ever used any but these Aryan languages. A large proportion of the brunet broad-heads once spoke the Ligurian and the Rhætic dialects, which are believed to have been non-Aryan. But, when the Romans made acquaintance with Transalpine Gaul, the inhabitants of that country between the Garonne and the Seine (Cæsar's *Celtica*) seem, at any rate for the most part, to have spoken Celtic dialects. The brunet long-heads of Spain and of France appear to have used a non-Aryan language, that Euskarian which still lives on the shores of the Bay of Biscay. In Britain there is no certain knowledge of their use of any but Celtic tongues. What they spoke in the Mediterranean islands and in south Italy does not appear.

The blond broad-heads of Poland and west Russia form part of a people who, when they first made their appearance in history, occupied the marshy plains imperfectly drained by the Vistula on the west, the Duna on the north, and the Dnieper and Bug on the south. They were known to their neighbors as Wends, and among themselves as Serbs and Slavs. The Slavonic languages spoken by these people are said to be most closely allied to that of the Lithuanians, who lay upon their northern border. The Slavs resemble the south Germans in the predominance of broad-heads among them, while stature and complexion vary from the, often tall, blonds who prevail in Poland and Great Russia to the, often short, brunets common elsewhere. There is certainly nothing in the history of the Slav people to interfere with the supposition that, from very early times, they have been a mixed race. For their country lies between that of the tall blond long-heads on the north, that of the short brunet broad-heads of the European type on the west, and that of the short brunet broad-heads of the Asiatic type on the east: and throughout their history they have either thrust themselves among their neighbors, or have been overrun and trampled down by them. Gauls and Goths have traversed their country, on their way to the east and south: Finno-Tataric people, on their way to the west, have not only done the like, but have held them in subjection for centuries. On the other hand, there have been times when their western frontier advanced beyond the Elbe; indeed, it is asserted that they have sent colonies to Holland and even as far as southern England. A large part of eastern Germany; Bohemia, Moravia, Hungary; the lower valley of the Danube and the Balkan Peninsula, have been largely or completely Slavonized; and the Slavonic rule and language, which once had trouble to hold their own in west Russia and Little Russia, have now extended their sway over all the Finno-Tataric populations of Great Russia; while they are advancing,

among those of central Asia, up to the frontiers of India on the south and to the Pacific on the extreme east. Thus it is hardly possible that fewer than three races should have contributed to the formation of the Slavonic people; namely, the blond long-heads, the European brunet broad-heads, and the Asiatic brunet broad-heads. And, in the absence of evidence to the contrary, it is certainly permissible to suppose that it is the first race which has furnished the blond complexion and the stature observable in so many, especially of the northern Slavs, and that the brunet complexion and the broad skulls must be attributed to the other two. But, if that supposition is permissible, then the Aryan form and substance of the Slavonic languages may also be fairly supposed to have proceeded from the blond long-heads. They could not have come from the Asiatic brunet broad-heads, who all speak non-Aryan languages; and the presumption is against their coming from the brunet broad-heads of the central European highlands, among whom an apparently non-Aryan language was largely spoken, even in historical times.

In the same way, the tall blond tribes among the Finns may be accounted for as the product of admixture. The great majority of the Finno-Tataric people are brunet broad-heads of the Asiatic type. But that the Finns proper have long been in contact with the Aryans is evidenced by the many words borrowed from Aryan which their language contains. Hence there has been abundant opportunity for the mixture of races, and for the transference to some of the Finns of more or fewer of the physical characters of the Aryans, and *vice versa*. On any hypothesis, the frontier between Aryan and Finno-Tataric people must have extended across west-central Asia for a very long period; and at any point of this frontier, it has been possible that mixed races of blond Finns or of brunet Aryans should be formed.

So much for the European people who now speak Celtic, or Teutonic, or Slavonian, or Lithuanian tongues; or who are known to have spoken them before the supersession of so many of the early native dialects by the Romance modifications of the language of Rome. With respect to the original speakers of Greek and Latin, the unraveling of the tangled ethnology of the Balkan Peninsula and the ordering of the chaos of that of Italy are enterprises upon which I do not propose to enter. In regard to the first, however, there are a few tolerably satisfactory data. The ancient Thracians were proverbially blue-eyed and fair-haired. Tall blonds were common among the ancient Greeks, who were a long-headed people; and the Sphakiots of Crete, probably the purest representatives of the old Hellenes in existence, are tall and blond. But considering that Greek colonization was taking place on a great scale in the eighth century B. C., and that, centuries earlier

and later, the restless Hellene had been fighting, trading, plundering, and kidnapping, on both sides of the Ægean, and perhaps as far as the shores of Syria and of Egypt, it is probable that, even at the dawn of history, the maritime Greeks were a very mixed race. On the other hand, the Dorians may well have preserved the original type; and their famous migration may be the earliest known example of those movements of the Aryan race which were, in later times, to change the face of Europe. Analogy perhaps justifies a guess that those ethnological shadows, the Pelasgi, may have been an earlier mixed population, like that of western Gaul and of Britain before the Teutonic invasion. At any rate, the tall blond long-heads are so well represented in the oldest history of the Balkan Peninsula that they may be credited with the Aryan languages spoken there. And it may be that the tradition which peopled Phrygia with Thracians represents a real movement of the Aryan race into Asia Minor, such as that which in after-years carried the Gauls thither.

The difficulties in the way of a probable identification of the people among whom the various dialects of the Latin group developed themselves, with any race traceable in Italy in historical times, are very great. In addition to the Italic "aborigines" northern Italy was peopled by Ligurian brunet broad-heads; with Gauls, probably, to a large extent, blond long-heads; with Illyrians, about whom nothing is known. Besides these, there were those perplexing people the Etruscans, who seem to have been, originally, brunet long-heads. South Italy and Sicily present a contingent of "Sikels," Phœnicians and Greeks; while over all, in comparatively modern times, follows a wash of Teutonic blood. The Latin dialects arose, no one knows how, among the tribes of central Italy, encompassed on all sides by people of the most various physical characters, who were gradually absorbed into the eternally widening maw of Rome, and there, by dint of using the same speech, became the first example of that wonderful ethnological hotch-potch miscalled the Latin race. The only trustworthy guide here is archæological investigation. A great advance will have been made when the race characters of the prehistoric people of the terremare (who are identified by Helbig* with the primitive Umbrians) become fully known.

I can not learn that the ancient literatures of India and of Persia give any definite information about the complexion of the Indo-Iranians, beyond conveying the impression that they were what we vaguely call white men. But it is important to note

* Die Italiker in der Poebene, 1879. See, for much valuable information respecting the races of the Balkan and Italic Peninsulæ, Zampa's essay, Vergleichende anthropologische Ethnographie von Apulien, Zeitschrift für Ethnologie, xviii, 1886.

that tall blond people make their appearance sporadically among the Tadjiks of Persia and of Turkistan; that the Siah-posh and Galtchas of the mountainous barrier between Turkistan and India are such; and that the same characters obtain largely among the Kurds on the western frontier of Persia at the present day. The Kurds and the Galtchas are generally broad-headed, the others are long-headed. These people and the ancient Alans thus form a series of stepping-stones between the blond Aryans of Europe and those of Asia, standing up amid the flood of Finno-Tataric people which has inundated the rest of the interval between the sources of the Dnieper and those of the Oxus. If only more was known about the Sarmatians and the Scythians of the oldest historians, it is not improbable, I think, that we should discover that, even in historical times, the area occupied by the blond long-heads of Aryan speech has been, at least temporarily, continuous from the shores of the North Sea to central Asia.

Suppose it to be admitted, as a fair working hypothesis, that the blond long-heads once extended without a break over this vast area, and that all the Aryan tongues have been developed out of their original speech, the question respecting the home of the race when the various families of Aryan speech were in the condition of inceptive dialects remains open. For all that, at first, appears to the contrary, it may have been in the West, or in the East, or anywhere between the two. In seeking for a solution of this obscure problem, it is an important preliminary to grasp the truth that the Aryan race must be much older than the primitive Aryan speech. It is not to be seriously imagined that the latter sprang suddenly into existence, by the act of a jealous Deity, apparently unaware of the strength of man's native tendency toward confusion of speech. But if all the diverse languages of men were not brought suddenly into existence, in order to frustrate the plans of the audacious bricklayers of the plain of Shinar; if this professedly historical statement is only another "type," and primitive Aryan, like all other languages, was built up by a secular process of development, the blond long-heads, among whom it grew into shape, must for ages have been, philologically speaking, non-Aryans, or perhaps one should say, "pro-Aryans." I suppose it may be safely assumed that Sanskrit and Zend and Greek were fully differentiated in the year 1500 B. C. If so, how much further back must the existence of the primitive Aryan, from which these proceeded, be dated? And how much further yet, that real *juventus mundi* (so far as man is concerned) when primitive Aryan was in course of formation? And how much further still the differentiation of the nascent Aryan blond long-head race from the primitive stock of mankind?

If any one maintains that the blond long-headed people, among

whom, by the hypothesis, the primitive Aryan language was generated, may have formed a separate race as far back as the Pleistocene epoch, when the first unquestionable records of man make their appearance, I do not see that he goes beyond possibility—though, of course, that is a very different thing from proving his case. But, if the blond long-heads are thus ancient, the problem of their primitive seat puts on an altogether new aspect. Speculation must take into account climatal and geographical conditions widely different from those which obtain in northern Eurasia at the present day. During much of the vast length of the Pleistocene period, it would seem that men could no more have lived either in Britain north of the Thames, or in Scandinavia, or in northern Germany, or in northern Russia, than they can live now in the interior of Greenland, seeing that the land was covered by a great ice sheet like that which at present shrouds the latter country. At that epoch, the blond long-heads can not reasonably be supposed to have occupied the regions in which we meet with them in the oldest times of which history has kept a record.

But even if we are content to assume a vastly less antiquity for the Aryan race; if we only make the assumption, for which there is considerable positive warranty, that it has existed in Europe ever since the end of the Pleistocene period—when the fauna and flora assumed approximately their present condition and the state of things called Recent by geologists set in—we have to reckon with a distribution of land and water, not only very different from that which at present obtains in northern Eurasia, but of such a nature that it can hardly fail to have exerted a great influence on the development and the distribution of the races of mankind.—*Nineteenth Century.*

[*To be continued.*]

## THE STORAGE OF ELECTRICITY.

By SAMUEL SHELDON, Ph. D.,
PROFESSOR OF PHYSICS IN THE POLYTECHNIC INSTITUTE OF BROOKLYN.

THE problem how to save and store up the enormous amount of natural energy which is daily dissipated in producing natural phenomena has long occupied the attention of scientists. During the last fifteen years this attention has been especially directed toward electricity as an agent. This is, perhaps, because the majority of the really active investigators have been occupied in this department of science, or perhaps the popular superstitious credulity that electricity can be made to do anything, has, to a certain extent, taken possession of the scientific mind. At any rate, the result of experiments has been the development of the

electrical storage batteries, or accumulators, as they are sometimes called.

The employment of these names for the apparatus is very unfortunate. They are the cause of the popular idea that electricity, which is considered as a subtle, indefinite, and intangible something, is stored up in them, as valuables are stored in a vault. The commercial current electricity can not, in large quantities, be stored and still preserve its character. It has but a flitting existence, and is no sooner produced than it dissipates itself and is converted into some other form of energy. It was because of this momentary existence that science had to wait so long for an accident to reveal to Galvani that such a thing could exist.

The energy which a current may at any instant be said to possess is immediately transformed into heat in the circuit, which will under certain conditions produce light; into chemical energy; into motion, which may or may not produce sound; or into magnetic and electrotonic conditions. The last may either be permanent or have the same evanescent existence as the original current.

When electricity is employed to charge a storage battery, only that part which is transformed into chemical energy is used. The rest is dissipated. The battery, then, instead of being a place where electricity is laid away, is a place where chemicals are left by the current, with the expectation that they will in turn produce a current when called upon. This may seem a fine distinction, but it is only apparently so. For instance, the current might be produced by a dynamo turned by Niagara water-power. The chemical left by it might be zinc deposited from a solution of zinc sulphate. This might be transported, preserved, bought and sold, and finally be employed by some physicist to produce another current. Were the electricity itself stored in its original form, then the imaginative reader can best tell what would become of it and how it must be handled.

To understand this transformation more clearly, and to obtain a clear idea of what goes on in a storage battery, one must first become acquainted with that part of electricity which treats of the phenomena resulting when a current of electricity passes through a liquid. This is called electrolysis, and the liquid through which a current can be made to pass is called an electrolyte.

If a current of electricity flows into a liquid solution of any metallic salt by means of a wire, and if, after traversing it, it flows out through another wire, then it will, by its passage, separate the salt into two parts and deposit the metal upon the latter wire.

If, for instance, the solution be one of silver cyanide, then silver will be deposited on the second wire. If a brass fork be connected with this wire and dipped in the solution, then it will receive a

coating of silver by the process and will be silver-plated. Substitute a solution of nickel nitrate, and the article would become nickel-plated. By using copper sulphate we are enabled to cover the faces of types and cuts with a coating of copper, which increases their hardness and consequently their endurance.

This electrolytic action can be watched if a solution of tin chloride be used. Tin, instead of being deposited, like most other metals, in fine particles, comes out of the solution in quite large crystals. If the current of electricity be made to enter the solution through two wires, placed symmetrically on opposite sides of the wire through which it makes its exit, and the whole is performed in a vessel with glass sides, then, as the current passes, the crystals will appear, as if by magic, growing out around the central wire. This is but a modification of the "lead tree" which appears in many text-books on physics. The tin crystals, however, are much larger and more beautiful than those of lead.

The simplest storage battery, then, would seem to be one constructed of two copper plates suspended in a solution of some zinc salt. A current of electricity passed into this would deposit zinc upon one of the plates. After disconnecting the charging current, the battery of itself would give off a current until the zinc was redissolved. In fact, a modification of this form of storage battery has recently been placed upon the market. The question arises, however, whether it is cheaper to buy zinc sulphate and transform it by expensive horse-power into metallic zinc or to buy metallic zinc directly. Of course, in neither case is the zinc lost, for it can be recovered by chemical means from the solution. If solutions of zinc were abundant in nature and hence inexpensive, this style of storage battery would, undoubtedly, for economic reasons, prevail. Or, still further, if metallic zinc were inexpensive we would have no need of storage batteries at all, but could use primary batteries directly.

It might be well, right here, to define a primary battery. If any two different metals be dipped in an acidulated liquid, and if their external extremities be connected by a wire, a current of electricity will flow through the wire. Such a combination is called a primary battery. Under the same conditions the amount of electricity obtained depends upon the character of the metals. If nickel and iron were employed, a small amount of electricity would result. If, however, zinc be used in connection with either silver, gold, platinum, carbon, or copper, a large amount is obtained. The first three of the group are very expensive; hence, in most primary batteries, we find zinc combined with either carbon or copper, the differences between the various forms arising from difference in the liquids employed or in the shape of construction.

Furthermore, pieces of the same metal under different physical conditions, when combined with each other, will give a current. For instance, a piece of polished iron opposed to a rusty piece gives a current, and a plate of very rusty lead, if I may use the expression, combined with a piece of bright lead yields even more current than zinc and carbon. Unfortunately, lead does not rust sufficiently well to suit electricians, and other physical reasons prevent its being used in primary batteries.

It will thus be seen that a storage battery, when once charged, becomes nothing more or less than a primary battery. In the case before described, after charging, we have zinc and copper in a solution of zinc sulphate.

In describing the effects of electricity in passing through an electrolyte, we have assumed that the liquid contained a metal in solution. Suppose, now, that we take water, which has no metal in it, and subject it to the action of the current. The electricity can get no metal to deposit on the wire, where it passes out, and in consequence does the next best thing and leaves one of the components of the water—viz., hydrogen gas. The other component, oxygen, collects around the entrance wire. The English physicist Grove showed that, if these two wires, around which the gases had collected, were connected together, a current of electricity would flow the same as if there were two metals instead of two gases. Now, water is cheap, and if there were not some serious technical difficulties as regards efficiency, Grove's battery would be universally employed.

It was reserved, however, for M. Gaston Planté to construct the first practical secondary battery. He considered the following points in its construction: Water is cheap; water, when subjected to the electric current, gives off oxygen and hydrogen; rusty lead, when combined with bright lead, has a high electromotive force; oxygen makes lead rusty and hydrogen makes it bright. His battery consisted, then, of two lead plates suspended in water, which contained a little sulphuric acid to assist in the conduction. When a current of electricity was passed through, hydrogen was thrown off at one plate, making it bright, and oxygen at the other plate, peroxidizing its surface. When the charging source was removed, the altered plates would send off a current, which was in a direction opposite to the one which had charged them, and this would keep up until the plates had assumed their original condition.

Planté's choice of materials was most wise, and all practical storage batteries of to-day are but modifications of his style.

In order that his battery might give a strong current, and one that would last a long time, it was found necessary that his two lead plates should be as near to each other, and that they should

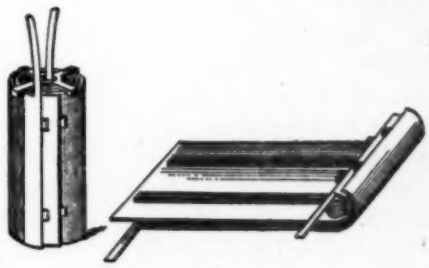
be as large as possible. He accomplished both of these ends with economy of space by winding large plates into a spiral form, they being separated from each other by strips of rubber.

In charging this battery, care must be exercised that the current be not too strong; otherwise the gases would be sent off too rapidly for the lead to take them up, and they would then rise to the top of the liquid and escape into the air. The electrical energy which separated them would thus be lost. It accordingly takes a long time to charge a new Planté battery to its full capacity. After being subjected to the current for a day or two, if the plates be removed and examined, it will be found that the one which received the oxygen has changed its physical character: instead of having a smooth surface, it presents a spongy appearance, having little holes and cavities in it, and thus exposes a larger superficial area.

PLANTÉ'S ACCUMULATOR.

If the battery be now discharged, and be again subjected to the charging current, it will be found that a much stronger current may be used than at first, without any gas escaping. This is owing to the much larger surface exposed and to the spongy character of it.

This original charging of a new battery, to change the character of the lead surfaces, has been termed *formation*, and, inasmuch as only one plate is altered by a charge in one direction, a complete formation consists in a charging in two directions.



PLANTÉ'S ARRANGEMENT OF PLATES.

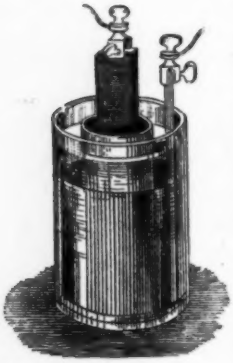
As the process of electrical formation is necessarily an expensive one, it was thought that the same end could be attained by mechanical means. Planté himself suspended the lead plates, for a few days, in strong nitric acid. The acid does not attack the lead, but seems to dissolve out small impurities, which are distributed throughout the metal, leaving it in a much more porous condition than after electrical formation.

Others cut the plates into fine fringes, thus exposing a large surface with a small weight of lead.

D'Arsonval, instead of using plates, employed lead shot, thinking to get the largest surface for the given weight. The particles could be effective, however, only under the condition that they were in good contact with the wires leading to the battery. After

becoming oxidized, a large proportion of the shot did not satisfy this condition, and the method was abandoned.

Lead wire was then substituted for the shot, and was found very efficient. Lead wire, however, is very expensive; and, to obviate this, Simmen invented a very ingenious and economical process of manufacturing it. This consists in pouring molten lead into heated iron boxes, the bottoms of which are perforated with suitable-sized holes. The metal flows through these holes, and is suddenly cooled by dropping into cold water. The wire thus manufactured does not possess the same regular character as drawn wire, but is perfectly suited to the purpose for which it was intended. The wire, after removal from the water, is compressed into sheets, which, under the microscope, resemble, in texture, coarse felt. Simmen placed pieces of this felt in frames of cast lead, which acted as supports and improved the electrical contact.



LEAD-SHOT ACCUMULATOR.

Reynier sought to increase the exposed surface by taking thin lead foil and forming it into accordion-plaits. The compressed plaits were then attached to supporting frames.

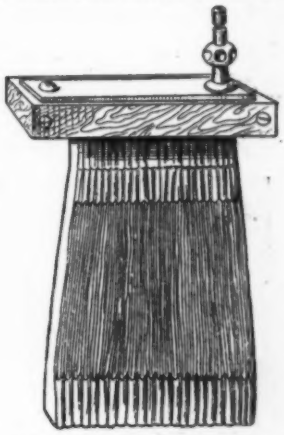
When Reynier's battery was charged, an unexpected phenomenon presented itself. The lead, in taking up the oxygen, had increased its weight. At the same time it had been transformed into peroxide of lead, which is less dense than pure lead—i. e., a pound of it would occupy more space than a pound of the metal. The plaits, therefore, required more room, and in expanding they buckled the frames holding them. To obviate this, Reynier then cut a longitudinal opening in the plaits after they had been placed in the frame, and when the battery was charged this opening was closed by the expansion.

LEAD-WIRE PLATE.

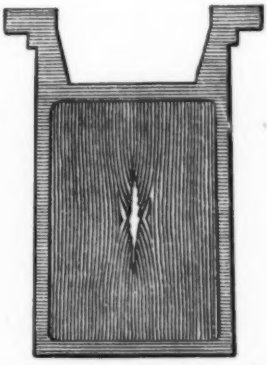
In all the styles of lead batteries mentioned, the oxide of lead on one plate and the spongy metallic lead on the other were formed from the lead of the electrodes themselves. Camille Faure, however, lessened the loss of time in formation by using lead plates as a support, and covering them with a paste made of some powdered oxide of lead mixed with sulphuric acid. This paste he kept in place by covering with sheets of felt. When the charging current was connected, the oxide on one plate was changed to a

higher oxide, and on the other plate transformed into metallic sponge. This idea of Faure was an excellent one, and is at the foundation of the construction of all the commercial lead accumulators. The percentage of energy recovered by discharge was greatly increased. His method of keeping the paste in place by felts was, however, soon abandoned, because fine lead needles soon filled up the interstices of the felt, and thus made a metallic connection between the electrodes. Holes were then punched in the lead plates and the paste pressed into them. A large number of the patents recently issued for accumulators refer to methods of making these holes and pressing in the paste, or to the shape of the holes themselves after they have been punched. The shapes vary from a slight depression on the surface to a hole completely

REYNIER'S PLAITS (uncharged).



REYNIER'S PLAITS (charged).



REYNIER'S MODIFIED PLAITS (uncharged).

REYNIER'S MODIFIED ACCUMULATOR (charged).

through the plate, and even further, to a hollow plate, with small openings leading to the surface. A great deal depends upon this shape, for the paste changes its volume during the process of charging and discharging, the same as the metallic lead does, and it would tend to loosen itself from some shaped openings and fall to the bottom of the cell, while in others it would tend to tighten itself, and thus provide a better contact.

Although the electrical end is obtained by substituting paste for metallic lead, yet this does not prevent the charging current from attacking the lead frames which hold the paste. These in time are rendered porous, and after a while they break under their own weight. To avoid this, alloys and many secret compo-

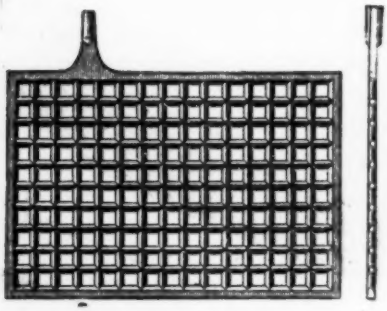


PLATE WITH HOLES OF LARGER EXTERNAL DIAMETER.

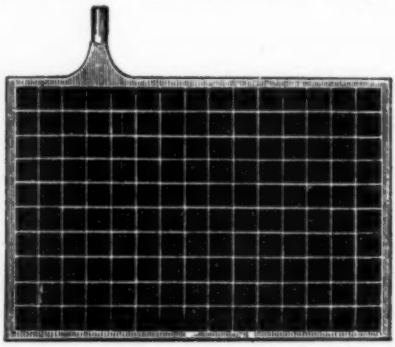


PLATE WITH HOLES OF LARGER EXTERNAL DIAMETER (filled with paste).

sition metals have been substituted for the lead frames. Even then, the continual change in volume of the paste contained in them twists and warps them so that new plates have to be substituted after a while. No good battery has yet been constructed which can be said to have a reasonably long life.

From what has been said it will be seen that the electricity which is used for charging an accumulator is apparently used in

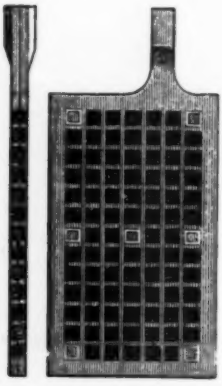
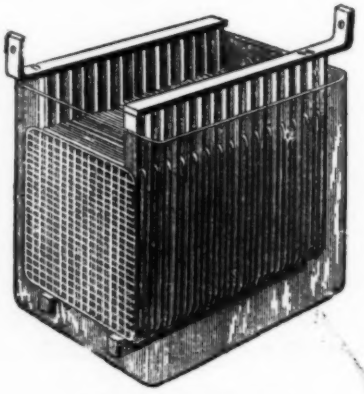


PLATE WITH HOLES OF LARGER INTERNAL DIAMETER (filled with paste).



MODERN ACCUMULATOR.

the production of oxygen and hydrogen gases. These are made to oxidize one plate and clean up the other. Now, an interesting question arises, whether it would not be more economical to employ gases, which can be more cheaply produced through chemical means. Difficulties, however, arise here, for the oxygen of

electrolysis is generated in the form of nascent oxygen, which is far more active than ordinary oxygen. A molecule of the ordinary gas contains two elementary atoms, which work upon each other; with the electrolytic generation, however, a single atom is sent off, and this is chemically very active. It is sometimes called ozone; but chemists say that a molecule of ozone contains three atoms. Now, there is no known method of chemically manufacturing ozone in large quantities, and ordinary oxygen does not produce the required effect.

Again, Planté's supposition, that the charging current produced these two gases only, is incorrect. The sulphuric acid in the water, which he supposed only assisted in the conduction, really acts upon the lead in forming lead sulphate. This has its use in preventing the charged battery from running down when not in use, and from too rapidly expending itself when put to use.

A more perfect system of storage batteries is much to be desired. Already electricity is a staple article, and has a market price of so many cents per ampère-hour. But its sale is of necessity confined to limited areas. As soon as these can be extended, by means of storage, an improvement in our commercial welfare will become apparent, and the fear arising from the predicted loss of our coal-supplies, will not trouble the minds of our immediate posterity.

## ELEMENTARY BOTANY IN GENERAL EDUCATION.*

By Prof. MARSHALL WARD.

AS I understand it, we may regard the study of botany as approachable from three points of view. We may speak of three ends to be attained: those of (1) elementary botany as a school-subject of general education; (2) advanced botany, as a subject of university or academic training, with a view to teaching and research; (3) special botany, for various purposes in after-life—e. g., those of foresters, planters, agriculturists, horticulturists, brewers, medical men, timber merchants, etc.

This is, of course, a merely aribitrary division for the argument, and not a philosophical classification of the subject-matter of the science of botany.

The next point is the scope of the teaching in each case. I should advocate that all children pass through the preliminary training embraced under No. 1. Not only so, but I would urge the usefulness and importance of elementary botany in schools quite apart from its possible pursuit afterward.

* From a discussion at the Leeds Meeting of the British Association for the Advancement of Science, reported at length in Nature for October 23, 1890.

It seems to me that the time is gone by when we need discuss the direct applicability of teaching in elementary schools; if school training is read to mean education in the true sense of the word, then there is no necessity for asking that a boy and girl should learn at school only those subjects of which they will make direct application as they grow older. Of course, this does not preclude our keeping in mind the relative utility of the various subjects to be taught, but it does—and emphatically—preclude our falling into the error of imagining that a school-subject is of educational value only in proportion to its direct and foreseen utility in the application afterward. In other words, education and teaching may be, and often are, very different things.

Now, as I understand it, the nineteenth century has discovered—possibly rediscovered—the truth that you may impart a wondrous amount of information to a boy or girl without awakening those powers of observing and comparing that lie dormant in the minds of most healthy human beings, and especially when young; and that many a brilliant boy grows up without being able to draw correct inferences from the phenomena around him, and therefore less able than he should be to hold his own in the world he awakes in.

The peculiarity of the study of elementary botany, properly understood and pursued, lies especially in the interest it arouses in the child's mind, and the ease with which it may be taught, and I would insist and reinsist on the fact that it stimulates and cultivates just those powers of accurate observation and comparison, and careful conscientious recording of the results, which are so needed by us all; and which, be it understood, moreover, come so naturally to children who are not too much under the baneful influence of the mere instruction—the mere information—system.

What I wish to emphasize is that the educational value of this subject is no more to be measured merely by the number and kind of *facts* which the child remembers, than is the educational value of history to be measured by the dates learned, and the lists of kings and battles committed to memory. History, reading and writing, arithmetic, and other subjects, have an educational value, if properly taught, quite apart from their value as mere accomplishments, which may be granted; but children are naturally observers, and why this side of their hungry little natures should be starved at the expense of their usefulness in after-life has always been a mystery to me.

To those who allow this, and I am happy to see that their numbers are now many, it should hardly be necessary to point out that the elements of botany afford the cheapest, cleanest, and most

easily attained means of cultivating in children the powers of observing and comparing direct from Nature, and of leading them to generalize accurately.

Of course, no advocacy is needed for good preliminary education in elementary botany in the case of those who are about to continue the pursuit of the subject as an academic study, or for a special purpose, as noted under the headings (2) and (3); but a few words may be devoted to pointing out the shocking waste of time and energy on the part of all concerned in the prevailing cases where students come up to a university, or other institution for higher education, insufficiently prepared for progressive study.

It is still true that boys and young men leave school without so much as a notion of the real meaning and aims of science; this applies no less to subjects like physics and chemistry, which are professedly much taught in schools now, than to subjects like natural history and botany, which, though avowedly in the curriculum of some good schools, are usually entirely ignored.

There is considerable discussion about the details, but many practical teachers regard such subjects as unfitted for school, because the boys and girls soon cease to be interested, and get lost in the masses of facts and hard names that beset their path; this, to my mind, simply shows where the whole system is wrong, and wrong because the tyrant empiricism still rules the prevailing methods of teaching in schools.

I shall go so far as to say that the only remedy for this state of things is for the teachers to lose that blind worship of facts, as facts, which dominates our school system. I am aware that this lays me open to very serious misconstructions, but I hope to make that all right in the sequel.

I would say to the teachers, therefore, Do not fall into the mistake of measuring a boy's progress by the amount of dogmatic information which he imbibes, and splutters forth upon his examination papers, but look to the quality of his understanding of the relations between relatively few and well-chosen facts; and again, pay less attention to the number of facts which a boy observes and of names he remembers, and more to the way in which he directly makes his observations, and intelligently describes them, even if untechnically.

This is, I firmly believe, the only cure for the malady under consideration—i. e., it is the prevention of it.

Children in schools are taught most subjects from printed books, and it is not my province to criticise the necessity of this as regards those subjects; but let a competent teacher try the experiment of making the children read directly from Nature, and he will soon see that the new exercises have a powerful

effect. They will stumble, and they will even make stupid mistakes and mispronunciations; but do they not do so when they are reading—i. e., observing and comparing and interpreting—printed words in a book? Of course they do, and therefore the teacher must not be discouraged by their stumbling and misapprehending when first they have to look at and compare different leaves and flowers, and give forth the articulate sounds which correspond to the impressions created on their minds.

Every weary teacher knows what a blessing is variety in the studies of the class, and it passes my comprehension why advantage is not taken of the splendid opportunity offered by the study of elementary observational botany.

We now come to the important subject of method. How should botany be taught?

Elementary botany in schools should be confined to lessons in observation and comparison of plants, and the greatest possible care should be taken that books are not allowed to replace the natural objects themselves. Indeed, I would go so far as to advise that books be used only as an aid to the teacher, were it not that a judiciously written text-book might be employed later on by even young children as a sort of reading-book.

The chief aids should be the parts of living plants themselves, however, and, in spite of the outcry that may be expected from pedantic town teachers, I must insist that every school might be easily provided all the year round with materials for study. I even venture to think that these materials might be collected by the children themselves; at any rate, there should be no difficulty about this in the country.

I will illustrate these remarks by a few examples. The teaching of elementary botany to children should commence with the observation of external form, and might well be initiated by a comparative study of the shapes of leaves, the peculiarities of insertion, their appendages, and so on.

The point never to be lost sight of is that if you teach a child to discriminate, *with the plants in hand and from observation only*, between such objects as the simple, heart-shaped, opposite, ex-stipulate stalked leaves of a lilac, and the compound, pinnate, alternate, stipulate leaves of a rose, you lay the foundations of a power for obtaining knowledge which is in no way to be measured merely by the amount or kind of information imparted. It does not matter whether the child learns the trivial facts mentioned above, or not, but it is of the highest importance that the child be taught how to obtain knowledge by such direct observation and comparison; and the beauty of it all is that, as is well known, the child will retain most of such information as mere matter of course.

For the main purpose in hand, therefore, it may be contended that any objects would do.

This is no doubt true in one sense, but it should not be forgotten that (1) the mental exercise on the part of the child is best exerted on *natural objects*, to say nothing of the admitted advantages of familiarizing him with Nature; and (2) the parts of plants are so varied, so beautiful, and so common, that he need never lack materials for his simple and pleasant work. Moreover, the parts of plants are clean, light, and easily handled—practical advantages which recommend themselves.

I feel convinced that, if the teachers were not opposed to it, the subject would ere now have been more widely taught; and I shall therefore say a few words in anticipation of difficulties. It has been suggested that materials would be scarce in winter. Not at all. Let the children be familiarized with the observation and comparison of the peculiarities of a sprig of holly as contrasted with one of ivy; or let them be shown how different are the buds and leafless shoots of the beech from those of the oak or the horse-chestnut. Show them how to observe the bud-scales, how to infer the leaf-arrangement from the scars, how to notice the color, roughness, markings, etc., of the periderm. Or give them introductory notions as to the nature of a hyacinth bulb as contrasted with the potato tuber, confining their attention to points which they can make out by observation. Every nut or orange or apple that the child eats might be made interesting if teachers would dare step over the traces of convention, and introduce such ostensibly dangerous articles into class-work—and why not? The doctrine of rewards and punishments is applied more crudely than this in most children's schools!

Be this as it may, there is no lack of material, at any season, for children to observe and compare, plant in hand, the peculiarities of shape, color, insertion, markings, etc., of the leaves, stems, roots, and other parts. The difficulties are supposed to increase when the flower is reached; this is not necessarily the case in the hands of a sympathetic teacher, unless the choice of flowers is very unfortunate and limited.

There is one danger to be avoided here, however. Young children should not be troubled with the difficulties of theoretical morphology; they should be made familiar with the more obvious roots, stems, leaves, tendrils, thorns, flowers, bulbs, tubers, etc., as such, and comparatively, and not forced to concern themselves with such ideas as that the flower is a modified shoot, the bulb a bud, the tendril a leaf or branch, etc., until they have learned simply to observe and compare accurately. Later on, of course, the step must be taken of rousing their minds to the necessity of

drawing further conclusions from their comparative observations in addition to recording and classifying them; but, if the teacher is really capable of teaching, it will be found that the children begin to suggest these conclusions themselves, and, this stage once reached, the success of the method is insured.

Glimpses of the meanings of adaptations of structure to function soon follow, but they should be obvious and simple at first, and the mistake should not be made of entangling a child in a discussion as to more remote meanings. It should never be forgotten, in fact, that the first steps consist in learning to observe accurately and to record faithfully, comparative exercise being used in addition, both as a check and as a stimulus to the judgment.

## THE INTELLIGENCE OF CATS.

By W. H. LARRABEE.

QUESTIONS concerning the quality or faculty in animals comparable with human reason and the extent to which it is developed in them are much discussed. Mr. Romanes discriminates between those ideas of quality that spring from mere sensuous impressions and those elaborated notions that arise from the more complex associations supplied by mental reflection, and assumes that brutes have a power of thought of the former or inferior order. The Rev. George Henslow admits that they reason as we do, but always in connection with concrete phenomena, whether immediately apprehended by the senses or present to consciousness through memory; but that they have no power of conveying truly abstract ideas. Prof. Exner regards them as capable of certain determined combinations in view of specific ends which are variable within very narrow limits. Some of the recorded instances of the exercise of thought by animals suggest that the sphere of their action in this line is often capable of considerable enlargement.

In a former article were considered some of the friendships which cats appear to form with human beings, particularly with the members of the families in which they live. The discussion might be continued indefinitely, and illustrated by incidents without number. Of equal interest are the associations which they are capable of forming with other animals.

We have only an imperfect knowledge concerning the relations of different animals toward one another. We can conceive the relative feelings of an animal that pursues and one that is pursued, and can comprehend that there should be jealousies and disputes between rivals for the same prey. We perceive animals

of social habits mingling across the lines of species without much difficulty, and also, perhaps, without much real intimacy. But there are a large class of other animals that are naturally neutral as toward one another, concerning whose mutual attitudes an ample field for inquiry is open. Cats belong to a family of soli taries. In a state of nature they form only passing relations, and have more quarrels than friendships with members of their own species. We should hardly expect them to be particularly sociable, or even friendly, across the line. Yet they can be made to form companionships when brought into association with other animals under the same roof, and some that seem very strange to the superficial view. The term "cat-and-dog life" is frequently used to describe a condition of discord; but cats and dogs often dwell very harmoniously together. Lindsay regards the phrase as implying an insult to both animals. Both he and Wood assert that the two can be trained to be very good friends, and that when this occurs "the cat usually behaves in a tyrannous manner toward her canine friend," and treats him most unceremoniously. "She will sit on his back and make him carry her about the room; she will take liberties with his tail, or bite his ears, and if he resents this treatment she deals him a pat on the nose," * and raises her back at him or retires till his good humor returns to him. The description will be recognized in thousands of families as acurate. Wood supplements his observation with a story of a cat and dog who had become great friends, when the dog was taken away. He afterward returned, with his mistress, on a visit. "Pussy was in the room when the dog entered, and flew forward to greet him; she then ran out of the room, and shortly returned, bearing in her mouth her own dinner. This she laid before her old friend, and actually stood beside him while he ate the food with which she so hospitably entertained him." † The natural attitude of the dog and cat may be regarded as one of rivalry for the same food and attention, and therefore of jealousy. The dog, being usually the larger and stronger animal, is likely to look upon the cat as his victim. This excites distrust and hostility in her, and the foundation of a feud is laid, which can be repressed or cultivated. An unnamed cat in Belfast, Maine,‡ became attached to a pig, and was its constant companion—sleeping with it at night and following it about by day. When Piggy was slaughtered, Pussy's grief was "pitiful to see. She watched by the lifeless body all night, and was found there in the morning; and could never be persuaded to eat a mouthful of its pork." Tabby, of Belfast, who had a kitten, became interested in a pig which

* Wood. † This story was told to Mr. Wood by the owner of the cat.
‡ The cat stories from Maine are cited from the Belfast Republican Journal.

had been brought half frozen to the house to be taken care of. She was found in his box trying "to quiet him and get him to accept her as his mother. Her kitten would cry, and she would leave the pig for a few minutes and go and quiet that, and then she would go back to the pig and try her best to make him comfortable." At last she took her kitten into the box with the pig. Rosy, an excellent ratter on a Belfast schooner, made friends at once with a pet rat that was brought on board, slept and played with it for two weeks, and allowed it to take many liberties with herself. Don Pierrot de Navarre and Seraphita, cats of Théophile Gautier, lived on the most friendly terms with their master's troop of white rats. Don Pierrot was especially fond of the rats, and would sit by their cage and watch them for hours together. If the door of the room where they were kept happened to be shut, he would insist, by scratching and mewing, on its being opened to him. Tabby, of Hyde Park, near Boston, having lost her kittens, took a brood of motherless chickens under her care. Knowing of them, she begged to be admitted to them. The experiment was tried. She looked at them a moment, then sprang into the box and, purring, nestled down among them. This was the beginning of a constant service of six months, during which Tabby would play with the chickens; would try to carry them by the neck as she would her own kittens; and persisted in licking their feathers the wrong way.

Mr. J. M. Coffinberry, of Cleveland, Ohio, writes to us that when, some forty-three years ago, he took possession of a certain house in Findlay, Ohio, the attention of the family "was called to a brood of young chicks by a cat who seemed to devote her time and attention to them. The ground being covered with two or three inches of snow, my wife fed them regularly, so that we saw much of them. The cat frequently purred to them, and they came at her call and followed her as closely as young chickens follow the mother hen. They lodged together in a wood-shed adjacent to the house for about three months, but in the early spring the chickens, being well fledged, abandoned their winter quarters and flew into the higher branches of a fruit tree to roost. The cat purred and mewed, and seemed much disgusted at their change of lodgings, but soon accepted the situation and climbed to the tree-top and roosted with the chickens." This continued during the few months that the family occupied this house. Mr. Coffinberry asks some questions as to what was in the cat's mind or heart that prompted her to this parental act. It is easily explained if the qualities which he and many authors claim for cats are conceded to them. A correspondent, M—— C——, of Nature, tells of a cat and dog who, having been brought into the family at about the same time, grew up friends and fast com-

panions. They ate out of the same dish and slept on the same mat. The dog took the cat under his protection, and was particularly assiduous in defending his ward from a vicious black cat that troubled it. A correspondent of the London Spectator wrote concerning tomcat Blackie's interest in a dog who had been blinded by a carter's whip and had been nursed by his master. Observing that "Laddie" (the dog) had difficulty in finding his way to the door, and sometimes struck his head against the posts, she became accustomed to go for him when he was called and guide him in.

Wood gives, in his Natural History, an account of two cats called the "Mincing Lane Cats," who lived in a wine-cellar, and, one being old and the other young, appear to have agreed upon an interchange of services. "Senior" taught "Junior" to avoid men's feet and wine-casks in motion, and pointed out the best hunting-grounds, while "Junior" employed his youthful activity in catching mice for his patron. In consideration also of the mice, Senior gave up to Junior a part of his share of the daily rations of cat's meat. It is represented that the curious compact was actually and seriously carried out. This had the air of a commercial transaction, but another story told by Mr. Wood exhibits pure benevolence. A cat in a Norman château had every day more food than she could consume, and the waste of the surplus "seemed to weigh on her mind." So one day she brought a less well-fed cat from a roadside cottage, and, having satisfied herself, gave it what was left. Her master, observing this, gave her larger platefuls, when she brought in another cat from a greater distance. The master then determined to test how far the cat's hospitality would extend, and kept adding to the platefuls from time to time, as new cats were brought in, till Puss's dinner-party included nearly twenty guests. "Yet, however ravenous were these daily visitors, none of them touched a mouthful till their hostess had finished her own dinner." * An Angora cat belonging to M. Jumelin † would often bring a poor, half-starved cat home with him, and then would see that it was fed. On the last occasion of his doing this, "Master Cat seemed nervous and excited, and behaved as though he thought the case was urgent. He became more quiet, however, as soon as the dish was set down for the strange cat, and contentedly observed what was going on while the visitor was taking his meal. As soon as the dish was emptied he showed his guest to the door, bade him good-by with a friendly but lively stroke of his paw, and accompanied him down the stairs, addressing him a succession of friendly mews."

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* Mr. Wood's informant had this story from the owner of the château.

† Revue Scientifique.

Cats appear taciturn in ordinary life, but every one knows that they can upon occasion, and that often, speak forcibly enough. They also have a language for their friends, varied and expressive enough to convey their wants definitely, and make intercourse with them pleasant and lively. Those who know them best may readily say, with John Owen, in the London Academy:

> "Thou art not dumb, my Muff;
> In those sweet, pleading eyes and earnest look
> Language there is enough
> To fill with living type a goodly book."

Montaigne observed, some three hundred years ago, that our beasts have some mean intelligence of their senses, well-nigh in the same measure as we. "They flatter us, menace us, and need us; and we them. It is abundantly evident to us that there is among them a full and entire communication, and that they understand each other." Dupont de Nemours, who undertook to penetrate the mysteries of animal language, recognized that animals had few wants, but these were strong, and few passions, but imperious, for which they had very marked but limited expressions. He thought the cat was more intelligent than the dog, because, being able to climb trees, she had sources of ideas and experiences denied to him; and, having all the vowels of a dog, with six consonants in addition, she had more words. The Abbé Galiani pretended to have made some curious discoveries respecting the language of cats, among which were those that they have more than twenty different inflections, and that "it is really a tongue, for they always employ the same sound to express the same thing." Champfleury professes to have counted sixty-three varieties of mewings, the notation of which, however, he observes, is difficult. The sign and gesture language of the cat is even more copious and expressive than its audible language. As Mr. Owen has it:

> "What tones unheard, and forms of silent speech,
> Are given that such as thee
> The eloquence of dumbness man might teach!"

Lindsay enumerates, as among the elements of the non-vocal language of cats, capers or antics, gambols, frolic, and frisking in the kitten; prostration, crouching, groveling, crawling, cringing, and fawning; hiding, flight, sneaking, skulking, slinking, shirking, or shrinking; rubbing against the bodies of other animals or against hard substances; licking; touching or tapping with the paws; scratching; head-shaking, tossing, or rubbing; and tail-movements, of which there are many. Dr. Turton says that "the cat has a more voluminous and expressive vocabulary than any other brute: the short twitter of complacency and affection, the

purr of tranquillity and pleasure, the mew of distress, the growl of anger, and the horrible wailing of pain." Besides these, the expressions of the countenance, as Mr. Owen teaches in his poem, are as lively and varied in the cat as in any other animal. The well-bred cat can put these diversified means of expression to uses commensurate with nearly all her wants; and the sagacious and sympathetic master can with no very great difficulty learn to translate them as accurately as he responds to the wishes of his child.

Romanes gives several instances illustrating the applications of this sign-language. A cat, observing that a terrier received food in answer to a certain gesture, imitated his begging. Another would make a peculiar noise when it wanted a door opened, and, if its wish was not attended to, would pull at one's dress with its claws; then, having secured notice, would walk to the door and stop with a vocal request. Another cat, having found its friend the parrot mired in the dough, ran up-stairs to inform the cook of the catastrophe, "mewing and making what signs she could for her to go down," till at last "she jumped up, seized her apron, and tried to drag her down," and finally succeeded in getting her to rescue the bird. Other cats are mentioned which would jump on chairs and look at bells, put their paws upon them, or even ring them, when they wanted anything done for which the ringing of a bell was a signal.

The extent of the cat's understanding of human language must depend considerably on the treatment and training it receives. An animal that is treated unkindly or is neglected can not be expected to learn much beyond the knowledge which its natural instinct confers upon it. Another animal, not necessarily brighter, but having better opportunities and more encouragement, may readily acquire knowledge of all the things that it is important one of its kind should know. Cats having appreciative masters and playmates will gain a really remarkable degree of knowledge of the tones, gestures, words, thoughts, and intentions of their human friends. Many of the well-authenticated stories on this point reveal faculties of perception that must seem astonishing even to persons well informed respecting the mental powers of animals. Careful observation of his own puss can hardly fail to convince any one that they understand more of ordinary conversation, as well as of what is said to them directly, than we are apt, at first thought, to suspect. Lindsay has shown that, in common with other tamed and domestic animals, they understand one or more of the modes in which man expresses his ideas, wishes, or commands, as well as those ideas, wishes, and commands themselves, however expressed, particularly the calls to receive food, and their own names. They also, in common

with a smaller number of animals, appear to know the names of the different members of the family, and of articles of domestic use. An instance is cited from Clark Rossiter of a cat that knew the name of each member of the household, and, his seat at the table. If asked about an absent one, she would look at the vacant seat, then at the speaker, and, if told to fetch him, would run upstairs to his room, take the handle of the door between her paws, mew at the key-hole, and wait to be let in.

The mistress of Topsey, of Belfast, an invalid, expressed a desire to have a partridge or a chicken for a broth. Some one spoke of having seen a flock of young birds in the morning, and immediately afterward Topsey sprang into the window with a partridge and laid it at her mistress's feet. The mistress commended the cat, and added, "If you will go and get another, you and I will have a nice dinner to-morrow." She went out, and shortly brought in another bird, which she also laid at her mistress's feet. Although very fond of birds, she declined to eat these herself. She was told not to catch any more birds, and brought no more to the house.

Dollie, of North Monroe, Maine, had one of her legs torn off by a railroad train. Her mistress, believing her case a hopeless one, begged two boys, in her presence, to take her away and kill her. "Instantly," says the teller of the story, "the look of patient trust with which she was regarding her mistress as she pitied and petted her, changed to one of terror as she got up and rushed out of the house." She was found, and fed, but would not return to the house till her wound was healed. Daisy, of Belfast, persisted in laying her kitten in her mistress's bed till the lady, looking her in the eye, told her if she did so again the kitten should be drowned, when she ceased offending. June, of Stockton, Maine, behaved in such a way as to lead the family to suppose that her kittens, which she had hidden under the floor of a back room, had died. The matter was talked about in the presence of the cat, who seemed to be sleeping on a lounge, and the relator of the story remarked that she "would give ten dollars in a moment if the kittens were out from under the floor." June rose at once and went to the door. It was opened for her, and she went up the stairs. After going up and down several times, she rattled at the door-knob; when the door was opened she looked into the lady's face and mewed. Three of her dead kittens were lying on the floor. The lady said: "Well done, June; go and get the other one." She went and brought it, then looked into the lady's face and mewed again. Spot, of Camden, Maine, answered when she was asked if she wanted anything to eat; and if her answer was negative, she would not eat, even if she was fed. Coonie, of Belfast, when directed in the morning to "go call the children,"

would go up the stairs, into every room, jump upon the bed and wake up each one; and, if it was early, would stay in the rooms a little while, but, if it was late, would hurry down-stairs. A cat at Poor's Mills, Maine, would hold up her right or left paw, or both, correctly, as she was directed, previous to receiving her food. Théophile Gautier's Eponine, a "delicate, lady-like cat," was allowed to sit at the table at dinner. Although she preferred fish, she would eat her soup first, when reminded, in polite language, that a person who had no appetite for soup ought to have none for fish.

Some of these acts may be only coincidences; but observation for ten years of my own cat, concerning whom it has often been remarked that she seemed to understand what we were talking about and was listening to it, has satisfied me that more of them were done with knqwledge. The story of the adventure of Théophile Gautier's Madame Théophile with the parrot, on first being introduced to it, indicates a comprehension of the significance of language, and has its humorous side also. The cat, looking upon the bird as a "green chicken," stealthily approached it as with the intention of seizing it. The watchful bird, at the critical moment, asked her, in good French: "Have you breakfasted, Jockey; and on what—on the king's roast?" and broke out into song. The astonished cat retreated hastily, and hid for the rest of the day, but renewed her attack on the morrow, to be rebuffed in the same manner. From that time she treated the parrot with the respect due to a being having the power of speech.

Montaigne says: "When I play with my cat, how do I know whether she does not make a pastime of me, just as I do of her? We entertain ourselves with mutual antics; and if I have my own times of beginning or refusing, she, too, has hers." The sportiveness of kittens is exuberant, and makes them the most delightful of pets. Lindsay's remark is superfluous, except that it has to be made for the formal completeness of his treatise, that dogs and cats take part in the fun and frolic—sometimes rough or boisterous enough—of their child playfellows. They give every evidence, in fact, that such fun and frolic are the most enjoyed features of that period of their lives. As the animal matures it becomes more sedate, and even assumes a meditative air, but the taste for sport does not die out till infirmity begins to wear upon it. A cat mentioned in the Animal World would allow itself to be rolled up or swung about in a table-cloth, and seemed to enjoy the fun; and Wood's dignified Pusset would let his friends do anything they pleased with him—lift him up by any part of the body, toss him in the air from one to another, use him as a foot-stool, boa, or pillow, make him jump over their hands or leap on their shoulders, or walk along their extended arms, with perfect

complacency. At the same time he was keenly sensitive to ridicule, and, if laughed at, would walk off with every manifestation of offended dignity.

Lindsay names the cat as one of the animals that perpetrate practical jokes on each other or on man; that enter thoroughly into the spirit of the joke or fun, and enjoy and exult in its success; and cites in illustration of his principle an instance of a cat teasing a frog, seemingly to hear it cry. Tad, of Burnham, Maine, seems to have had the humorous sense in a more refined degree. He would sit in the yard, and, calling the neighboring cats together, would manœuvre as though giving them orders, till he got them to fighting; then would withdraw to one side, or to his seat upon the window-sill, and look on in evident amusement, swinging his large, bushy tail forcibly against the window-pane; but, when called into the house by his mistress, he always obeyed.

Knowledge of the ways in which certain common things are done and the capacity to apply it are so frequently shown by domestic cats that it is almost superfluous to mention particular instances of its exhibition. Most cats know how doors are opened, and can open them for themselves if the method of handling the latch comes within the compass of their powers of manipulation. Romanes asserts that, in the understanding of mechanical appliances of this character, they reach a higher level of intelligence than any other animals, except monkeys, and perhaps elephants. He thinks that the skill of these animals may be due to their having, in their flexible limbs and trunks, instruments adapted to manipulation, which they learn to use. This may be so, but it should be remembered that horses can open doors and gates with their teeth and noses, and cows with their horns. The behavior of cats before a looking-glass, when, failing to find the image palpable in the face of the mirror, they look or feel around behind it, is familiar. Having once satisfied themselves that there is nothing there, they recognize the fact, and cease to take any further interest in the phenomenon. So they and other animals know that they can go round a wall and reach a point on the other side of it; or can go round after the mouse which they have heard rustling behind the door. A noteworthy feat of door-opening is recorded by Mr. Romanes of his coachman's cat, which, having an old-fashioned thumb-latch to deal with, sprang at the half-hoop handle below the thumb-piece, hanging to it with one paw, depressed the thumb-piece with the other paw, and with her hind legs pushed at the door-posts till the door flew open. Mr. Romanes interprets this and another similar action which he records as involving a deliberate purpose, combined with a mental process which he treats as complex and very near akin to reasoning, and as involving definite ideas respecting the mechanical prop-

erties of doors. Mr. A. Petrie's cat would climb up by some list to the click-latch, push it up, and, hanging from the door, similarly push it away from the posts. The cat of Mr. W. H. Michael, of Queen Anne's Gate, St. James's Park, London, jumped four feet to the crank-latch of a casement window, caught hold of the crank with her fore feet, and pressed the window open with her hind feet. A cat belonging to Parker Bowman learned to open a window by turning a swivel and bearing upon the sash.

Some equally curious incidents, showing powers of contrivance and a degree of understanding of the relation of antecedent and consequent, are connected with cats striking door-knockers and ringing bells, or, if unable to do so themselves, asking to have them done. Mr. Belshaw tells, in Nature, of his kitten jumping upon the door and hanging by one leg while it put the other fore paw through the knocker and rapped twice. A London cat is described in Nature which by standing on her hind legs would reach the knocker and rap once; if this was not answered, she gave what is called a 'postman's knock'; and if this was not responded to, "tried a scientific rat-tat that would not disgrace a West End footman." It is added that she held the knocker in her paws as we would hold it in our fingers, and did not simply tip it up. Mr. J. J. Cole's cat, of Maryland, Sutton, Surrey, having observed that a servant went to one of the windows after hearing the flap of a letter-box attached to it moved by a postman, learned to have herself let in when shut out by also rattling the flap. Some alarm was excited at Mr. Lonergan's house in London by a mysterious knocking at a door which could not be reached from the outside except by climbing over a wall. At length, Mrs. Muffins, the cat, was detected as the author of the sounds, and it was found some time afterward that she had learned to produce them by pulling at the loose lower end of a strip of board running down at the side of the door, and allowing it to rebound. There is perhaps nothing very remarkable in an animal, having observed that the striking of the knocker or the pulling of the bell-knob was usually followed by the opening of the door, learning to imitate the act. But some cats have gone further than this, and have learned the connection between the wire and the bell, and to avail themselves of it in order to be let in.

Other acts are related of cats that give us a much higher conception of their mental powers, and even go a little way toward lifting them into the order of beings capable of real abstract reasoning. Kitty, of Belfast, Maine, having given a mouse to her kittens to play with, watched the sport for a while as if to see that the mouse did not escape, but at last bit it so as to disable it, and then went away. Two kittens, neighbors of Kitty's, disa-

greed over a squirrel which had been given them. Their mother cuffed them, then bit the squirrel in two, and gave half of it to each. Coonie, of Belfast, sitting on the window-sill by the side of the ladies of the family when the glass was much clouded, put up her paw and wiped off the mist. This act may be matched by animals breaking ice to get at the water, and horses scraping the snow from the ground to reach the grass beneath it, but it also shows capacity for adaptation to circumstances. The same Coonie usually had to suffer the loss of all but one of each litter of her kittens. She finally seems to have determined to choose the one that should be saved. She selected one, carried it away, and left the rest to their fate. A Scotch cat, of Greenock, where the family were in the habit of throwing out crumbs for the birds, hid in the shrubbery to catch one of the birds when they came up. One afternoon the crumbs were not eaten, and were covered with snow during the night. In the morning, Puss was observed picking the crumbs out of the snow and putting them on top, after which she retired to her hiding-place. This was noticed two or three times; and at last Puss's success in catching the birds forced the family to cease feeding them. Dr. G. Frost, of London, found his cat in the habit of waiting in ambush for the throwing out of crumbs for the birds. The practice of feeding the birds was left off for a few days; and Dr. Frost avers that he and another member of the household saw the cat herself scattering crumbs on the grass, "with the obvious intention of enticing the birds."* Mr. James Hutchings tells, in Nature,† of a cat which, finding a young blackbird fallen from its nest to the ground, spent several hours in keeping a strange kitten away from the young bird, and at the same time herself teasing it, in order to entice the parent, which was hovering around, within her reach. The cat showed wonderful persistency through several defeats, and played a variety of tricks to deceive or attract the parent bird, till Mr. Hutchings forcibly put an end to the cruel sport. A cat living in a hospital in Massachusetts is described in Nature, which discovered the blindness of one of the inmates, and regularly took advantage of the fact to steal a part of her meal from her. Mr. Lawson Tait relates that a mutual dislike arose between a visitor at his house and his family of unusually intelligent cats. Although the cats had always been scrupulously neat and clean, they regularly left a noxious mess at the guest's room door so long as he stayed at the house. Just as the slaughter of the whole tribe as nuisances had been determined upon, the visitor went away, and the objectionable deposit ceased.

A story is told in the Hartford Times of a cat which became

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* Nature, vol. xix, p. 519. † Vol. xii, p. 330.

very uneasy one summer midnight and ran from one bedroom-door to another with earnest mewing and crying. Having attracted the attention of one of the family, she led the way, watching carefully to see that she was followed, down the stairs and through the kitchen and cellar to the outside cellar-door, which had been left open. A house between Belfast and Hollywood, Ireland,* taking fire one night, the cat ran up-stairs to the servant-maid's room and pawed her face. The girl, only half aroused, turned to sleep again. After a few moments the cat returned and scratched the girl's face till she woke in earnest, and now smelling the smoke, aroused the rest of the family. The cat already mentioned, that went and brought help to deliver the parrot from miring in the dough, evidently realized the nature of the danger the bird was in, and how it could be remedied. Mr. James R. Gilmore's (Edmund Kirk's) cat, finding one night, when she came home from her rambles, that the door leading to the veranda was open, took pains to give notice of it to the family. The same animal, when the family were all in other parts of the house, ran up to her mistress and demanded to be followed. She led the lady directly to the kitchen, and there was a strange man who had intruded himself into the vacant room. Mr. Gilmore relates several other anecdotes of this cat, which show that she understood the value of human help in emergencies—particularly in cases where her kittens were in trouble—and upon whom to call. She also understood that whatever demands she might make upon her master in the daytime, his night's rest must not be disturbed. At that time she always went to her mistress.

A cat is told of in the Boston Post which was accustomed to go in the summer with the family to the country. On the occasion of one of the vacations she appeared anxious about her kitten, and at last put it in one of the trunks.

A cat and a starling belonging to Mr. Dupré, of Kensington, England, were great friends and almost constant companions. One day the cat suddenly pounced upon the starling, but, instead of making an end of it, took it carefully up and set it upon a table; then rushed out of the room to chastise a strange cat which had stolen into the house. The forethought it exhibited in securing the safety of its friend before going into the fight seems to justify our attributing to it the highest degree of intelligence which any of the authors we have quoted are willing to accredit to animals.

A cat of Mr. Brown, of Greenock, Scotland, having had some paraffin accidentally spilled upon it and set ablaze by a cinder from the fire, at once rushed out of the door and up the street for about a hundred yards; plunged headlong into the village water-

* Nature.

ing-trough; and then stepped out, shook herself, and trotted quietly home. She had been accustomed to seeing the fire put out with water every night.

Mr. J. Harvey Gibbons's cat, of University College, Liverpool, when indisposed at one time, wandered strangely about the house, with an evident inclination toward the coal-bunkers. They were left open for her, and she went to them at once, and searched among the coals till she found a piece covered with pyrites. She licked this vigorously, and afterward returned regularly to the bunkers for more of the medicine. Some powdered sulphur was given her, and was accepted as a substitute for the pyrites. Under this regimen she recovered her health.

A most remarkable story illustrating this trait is told in the Revue Scientifique by Dr. Cosmovici, of Roumania, concerning his cat Cadi. We may remark that this gentleman appears to have been a keen observer of intelligence in all animals. The winter of 1880 was very cold, fuel was high, and our doctor had to be economical. He was accustomed, therefore, after his morning fire had burned out, to work during the rest of the day wrapped in furs, while Cadi sat at his feet. On one of the cold days, Cadi would every once in a while go to the door and mew in a tone quite distinct from that of his usual requests. Dr. Cosmovici opened the door, and Cadi went half-way out, looking at him the while. He shut the door and Cadi came back and mewed. At last he gave himself up to the cat's desire and followed her. She led him straight to the kitchen, and thence to the coal-box, and got upon it without ceasing to look at her master. He got coal. Cadi next showed him the way to the wood-box; thence led him back to his room, and, once within it, to the fireplace, where she lifted herself up and arched her back. The fire was made, while Cadi looked on, manifesting her approval of the operation by caresses. When it began to burn, she stretched herself before it, satisfied.

## PREDISPOSITION, IMMUNITY, AND DISEASE.

By W. BERNHARDT.

IT is a generally recognized fact that whole classes and families of animals, as well as single individuals, frequently are liable to succumb to some influence apparently obnoxious to health, while others, although exposed to the same danger, prove exempt from such injury. This experience concerns the action of vegetable and animal poisons, as well as the attacks of the various diseases to which flesh is heir. Destitute of a satisfactory interpretation of these divergences, we have recourse to the expression "predisposition" for explaining the inability of offering resist-

ance to the foe—a word which does not actually explain the matter, but furnishes a convenient term. Germs of disease are to be found everywhere, but only predisposition permits its development. Immunity, on the contrary, is the condition of the system which prevents an outbreak. The fundamental cause of this condition is as little known as the cause of predisposition; only in a few cases have we been successful in tracing it back to certain chemical and physiological processes occurring in the body.

The action of carbon monoxide on different animals affords a suitable instance of what is called immunity, and illustrates the kind of circumstances on which it may sometimes depend. Carbon monoxide is an air-like compound, which is contained to a large amount in the illuminating gas produced by the decomposition of steam by red-hot coals, and to the presence of which the poisonous qualities of this gas are chiefly due. A mixture of one part of carbon monoxide and ninety-nine parts of common air, when breathed, will in a short time kill any of the warm-blooded vertebrates. Cold-blooded vertebrates, such as frogs, can for a considerable length of time stand the exposure to such an atmosphere; arthropoda or insects are not in the least affected by it—they possess immunity from it. Searching for the cause of these differences of effect, we find it to be the tendency of hæmoglobin, the albuminous matter constituting the red corpuscles of the blood, to combine with carbon monoxide. In the process of respiration in warm-blooded animals hæmoglobin takes up oxygen, which thereafter, as a necessary agent in the exchange of matter, is delivered to the different organs of the body. Carbon monoxide prevents the absorption of oxygen, being absorbed in its place; but, unfit as it is to replace oxygen in its vital functions, it causes serious derangements, which end in suffocation. In cold-blooded vertebrates respiration is of more subordinate importance; although, as well as in warm-blooded animals, it consists in absorption of oxygen by hæmoglobin, the need for oxygen is much lower; a frog can live for a considerable time without the accession of air. Hence the effect of carbon monoxide is a much slower one. The blood of insects contains no hæmoglobin; carbon monoxide is not absorbed by it, and is not a poison to them, provided that a sufficient amount of oxygen is always present. Carbon monoxide, consequently, acts as a strong poison upon warm-blooded animals; its effect is weaker in cold-blooded vertebrates; and insects are proof against its effects.

In a few instances only has the cause of immunity become as well disclosed as in the one mentioned. Neither differences of organization in animals nor in the constitution of the poisonous substance generally afford any clew for interpreting an exceptional want of effect. Unaccountable is the immunity of rabbits against

belladonna leaves (*Atropa belladonna*, deadly nightshade). You may feed them with belladonna for weeks without observing the least toxic symptoms. The meat of such animals, however, proves poisonous to any one who eats it, producing the same symptoms as the plant. Pigeons and various other herbivora are also to some degree safe from the effects of this poison, while in warm-blooded carnivora it causes paralysis and asphyxia. In frogs the effect is a different one, consisting of spasms. The meat of goats which had fed on hemlock has sometimes occasioned poisonous effects. Chickens are nearly hardy against nux vomica and the extremely dangerous alkaloid, strychnine, contained in it, while in the smallest amount it is a fatal poison to rodents. More remarkable yet in this respect is the immunity of *Choloepus Hoffmanni*, a kind of sloth, living on the island of Ceylon, which, when given ten grains of strychnine, was not much affected. Pigeons are possessed of high immunity from morphine, the chief alkaloid of opium, as well as from belladonna. Eight grains were required to kill a pigeon, not much less than the mortal dose for a man. Cats are extremely sensitive to foxglove (*Digitalis purpurea*), which on the contrary may be given to rabbits and various birds in pretty large doses. Many kinds of fish may be killed by just a trace of *Cocculus indicus*, although their meat is not made injurious by it. Laughing-gas, or nitrogen monoxide, a means used to relieve pain in light surgical operations, affects man more than any other creature; when breathed in a mixture of four parts of laughing-gas and one part of oxygen it produces a pleasant kind of intoxication together with diminished sensibility, though in animals no such effect has been observed.

The immunity of certain animals against the bite of venomous serpents is remarkable. Numerous observations have been recorded proving the polecat, hedgehog, and buzzard to be proof against the bite of the viper; it is mortal for most other animals of the same size and nearly related to them.

Immunity, however, is not limited to the relations of animals to poisons of vegetable or animal origin, but is manifested as well in conditions and processes in the healthy animal organism and in its susceptibility to diseases. The resistance offered by the living stomach of an animal to the dissolving effect of the juice secreted by the stomach itself has to be explained by immunity. A watery solution of pepsin—the digestive principle of the stomach—acidulated by muriatic acid, and thus, as to composition, corresponding to the digesting juice of living animals, upon addition of pieces of the stomach of any mammal, dissolves them, forming a perfect solution. The stomach of the living healthy animal, on the contrary, does not undergo the least change by the secreted juice; it is proof against the digesting effect of its

own secretion, as well as to a certain degree against various sickening external influences.

Prominent naturalists are at present occupied in inquiring for a reasonable way of interpreting the causes of sickness and the conditions of immunity from it, or the resistance offered by a sound organism. Sickness, as well as health, according to one of the prevailing theories, depends upon chemical causes, viz., on the presence and predominance of various complex substances generated in the juices and tissues of the body by unknown processes, in which bacteria may sometimes play an important part. According to another theory, the living animal cells are engaged in a continual struggle against intruding micro-organisms. Animal cells are considered as individuals similar in character to the order of *Amœbæ*, which are unicellular organisms of the class of *Protozoa*. Metschnikoff found that certain cells of the animal body are endowed with the faculty of swallowing and digesting intruding bacteria of every kind, harmless ones as well as pathogenic ones, or such as produce disease. Not all elementary organs of the body are equally qualified for this purpose, the function being intrusted to certain cells of the tissues and blood, which Metschnikoff calls *phagocytes*. Health as well as disease depends upon which party is victorious in the struggle. Health is insured as long as the cells are capable of overpowering the intruding bacteria; an animal in such a condition is secure against disease. Experiments performed by Metschnikoff have given evidence that the bacilli of splenic fever are easily devoured and digested by phagocytes. On the other hand, several observers of late have maintained that the liquid part of blood, the plasma, and even common albumen, possess the faculty of killing bacteria. This, however, appears improbable, and a final decision of the question has still to be expected in future.

Susceptibility to diseases is as variable as sensitiveness to vegetable and animal poisons. Judging from the current opinion that putrefying animal matter is the principal bearer and transporter of infectious germs, we are forced to ascribe a high degree of immunity to certain animals which, like swine, ducks, chickens, and rats, are accustomed to select their food from places where such matter is accumulated. Predisposition for splenic fever is stronger among herbivora than among carnivora; birds of prey seem to be quite free from it. Experiments on sheep, performed by Pasteur, the results of which were confirmed by application on a large scale, gave evidence that immunity against splenic fever may be acquired by systematic inoculation of the attenuated virus very much as small-pox is prevented by vaccination.

Various herbivora, chiefly horses, sheep, and goats, are exposed to a disease called "glanders," which ends by death in most cases.

White mice are safe against it. This circumstance of late occasioned R. Koch to ascertain, by experiments, whether predisposition to glanders might not be artificially induced by changing the composition of the animal juices. The change consisted in the formation of sugar in the blood of the mice, which received as food *phloridzin*, a crystalline compound, naturally preformed in the roots of fruit trees and easily splitting up into sugar and some other products. It undergoes a similar change when brought into the circulation of the blood. The result of these experiments was, that white mice lose their immunity and become susceptible to glanders when phloridzin is given to them; infection by this disease invariably took place when the mice were inoculated to the virus, and thus the proof was furnished that by changing the chemical conditions of an animal its immunity from infectious disease may be neutralized. This indicates that immunity in the present case, as in the action of carbon monoxide, depends upon the composition of the blood, predisposition being established when the composition is changed.

These facts indicate that, as to susceptibility to and immunity from the effect of poisonous and virulent matter, the composition of blood is of the highest signification, and that the changes caused chiefly relate to its condition. They coincide with the experience that the action of poisons throughout is quickest and most energetic when they are injected into the blood; moreover, there seem to be many substances existing which induce infection only when present in the circulation of the blood, but not when brought into the digestive channel. Apparently harmless lesions can turn out disastrously, when even the smallest trace of a virus happens to reach the wound.

## THE DECLINE OF RURAL NEW ENGLAND.

By Prof. AMOS N. CURRIER.

IN every period of American history the influence of New England has been marked and out of proportion to its size and population. In religious thought and activities, in great moral and social movements, in literature and scholarship, in inventive genius and the skilled industries, in the pulpit, at the bar, on the bench, and in legislative halls, New-Englanders have always stood in the front rank and have contributed largely to the worthiest American achievements.

Now, the bulk of this population, until very recent years, has been rural rather than urban, and the towns themselves, large and small, have been made up of the country-born and country-bred, while almost the entire stream of emigration that has

flooded and fertilized the Northwest has had its source in the hamlets and farms. It would be easy to show that the quality of this output from the rural districts has been even more remarkable than the quantity. Hence came Webster, Choate, Chase, Greeley, Cushing, Bryant, Whittier, Beecher, Hopkins, and a long list of notables that will occur to every reader. It may therefore be fairly claimed that what New England has been and what it has done, at home and abroad, through its citizens or through its colonists, has come in large measure from the country districts.

Hence the prosperity of this region concerns not merely New England, but the country at large. The testimony of many reliable witnesses and my own observations, covering more than twenty years, convince me that the outlook for the future is very unsatisfactory.

1. Fifty years ago almost every farm was cultivated by the owner, who had every interest in its most careful tillage, in making permanent improvements, and in the care of buildings, fences, and woodland. Hired labor was the exception, for the large families were quite competent for all the farm-work, the indoor as well as the outdoor, with a surplus which went to the aid of less fortunate neighbors, and sent brains and muscle to the city or to the opening West. Not all farmers were equally industrious, frugal, and successful, but there was a large body of landed proprietors, homogeneous in race, substantially on an equality socially, and alike interested in the present and future welfare of the community. In this respect there has been a great change in the last twenty years, and one which is going on more rapidly every year. The land is passing into the hands of non-resident proprietors, by mortgage, by death of resident owner, by his removal to the village or manufacturing center, or his emigration to the West.

It is also held in fewer hands, not as a general thing to be managed and worked in large estates, but to be rented from year to year.

The new proprietor has bought the farm at a small price, as compared with its former valuation, and has no interest or pride in it or its management except as an investment. So in every township there is an increasing body of renters, as a class unreliable, unsuccessful, shifting, and shiftless. Their interest in the property and the community is temporary, their tillage such as they suppose will bring the largest immediate returns with the least care and labor. It goes without saying that such farms and all their appurtenances are in a state of chronic decline. These renters are often bankrupt farmers, or young men without the pluck and thrift to become farm-owners, the courage and push to

go to the West, or the qualities in demand in the manufacturing towns.

In some towns is found an increasing element of Canadian French, good-natured, easy-going, thriftless people, living in a slipshod way from their labor when things go well, but, if sickness comes, or crops are short, or the winter long and hard, more or less dependent upon the poor-fund. This floating population, and especially its French element, is the bane of local and even State politics, especially in New Hampshire, for many of its voters are purchasable at least once at each election, and, as it holds the balance of power in many small towns, purchasers for both parties are rarely wanting, and prices rule high. I have personally known voters who openly counted their election wages an important item in the year's revenue. It will be readily believed that all public interests have suffered enormously by the substitution of such people for the thrifty, public-spirited farmers who preceded them. This French element is further objectionable in that it keeps itself aloof from the spirit of its adopted country, intact in language as well as religion, and has declared its purpose to change New England to New France.

2. Many farms are without resident cultivators, and in all probability will never again be homesteads. The New Hampshire Commissioner of Agriculture reports eight hundred and eighty-seven such farms, and these are only a small part. I know a district where eight contiguous farms have been thus abandoned, and, taking the farm on which the writer was born as the center, a circle with a radius of five miles would inclose twenty farms abandoned within the last few years.

Some of these have good buildings, stone fences, apple and sugar orchards, and all have made comfortable homes. On some of them a few acres of the best land are tilled, while the rest produces a lessening crop of hay or is used for pasture. The fine old orchards, uncared for, are wasting away, a lilac or a few rosebushes struggling for life in the grass show the site of the old garden, the buildings are falling to decay, and homesteads that have fostered large and prosperous families for generations are a desolation and will soon be a wilderness. In some districts the old country roads are becoming impassable from the growth of bushes and the cessation of all repairs. An eminent New England judge told me last summer that public sentiment in these districts will not allow a jury to find damages against the authorities in case of injuries to travelers from such defective highways, on the ground that the diminished population can not keep them in repair.

The abandonment of this rough country and the transfer of its population to more fertile regions or more remunerative em-

ployments may be no financial loss to the nation, but it robs New England of a hardy yeomanry, with whom the love of natal soil and home and simple life has been almost a religion.

3. Not only is the area of cultivated land decreasing in this way, but the land-owners are sensibly narrowing their tillage. The land is growing poorer, partly from natural causes and partly from less careful working and the marked decrease in the amount of live stock kept upon it. The fact is, farming does not pay, especially if help must be hired to do a large part of the work.

The farmer finds himself the victim of all the evils of a protective tariff without its supposed benefits. The promised home market he has found to his cost, if not his ruin, is a delusion and a snare. If the manufacturing centers in his vicinity have raised the price of some of his products, they have advanced the cost of labor in a greater degree, and drawn to themselves the best brain and muscle from the farms. He is being heavily taxed for the benefit of the whole list of these assistant industries that rob him of his working force, while the competition, intensified by labor-saving machines suited to the large prairie farms of the West and stimulated by lavish gifts of land to settlers and subsidies to railroads, ruinously reduces the prices of his products in his natural home market. He buys Western flour and Western corn for his own consumption at a cheaper rate than he can produce them with hired labor, and by reason of the long winter is unable to compete with the West and South in cattle-raising for the Eastern markets at his door. Confining his attention to the few crops that, from their bulk or perishable nature, are not subject to the destructive competition of the West, the ordinary farmer merely lives and pays current expenses, while his less shrewd and careful neighbor falls behind each year, and sooner or later will be sold out of house and home.

Naturally, there is a decay of heart and hope that blights growth and prosperity. Many farms within a hundred miles of Boston and not five miles from excellent railroad facilities will not sell for the cost of the improvements. The New Hampshire Commissioner of Agriculture gives a long list of farms with "fairly comfortable buildings, at prices from two dollars to ten dollars per acre," and a shorter list at higher prices. The Vermont Commissioner gives a list at from three dollars to five dollars per acre, and nearer to railroad or village, with better buildings, five dollars to ten dollars—"all at no great distance from market and adapted to doing business." I know of the sale of such a farm of fifty acres, with fair buildings, well supplied with water and fuel, at fifty-two dollars. What a paradise for the Henry George theorists!

4. Outside of the large towns and business centers the popula-

tion is stationary or dwindling with greater or less rapidity, according as the district in question is more or less exclusively rural. Then the percentage of young people and children is much smaller than fifty years ago. The old-fashioned large families are the rare exception, and the young folks are early drawn away from the old homestead. In my native town the school districts have been reduced from twenty-one to eleven, and many of these enlarged districts have only a half or fourth the pupils of the original divisions. The real decline of the native stock is greater than the decrease in numbers would indicate, for there is a decided increase in the foreign element, which with all its virtues is not qualified to strengthen and perpetuate the old New England type of character and spirit. Nor is this state of things confined to a few obscure places among the mountains, for some of the historic towns founded by the Puritans are undergoing the same process of decline or change of population. Many of the large towns, deprived of the former stream of recruits from the country, are fast changing from Anglo-Saxon to Celtic and from Protestant to Catholic.

5. In the last thirty years the colleges have been strengthened in endowments and appliances, and are doing a better and wider work than formerly; the larger towns have excellent high schools, and the well-endowed academies are strong and well attended. But, with the rural districts far removed from these advantages, there is no provision for secondary education. The ungraded district school, with its brief school term, is the beginning and the end of local opportunities. The unendowed academies of forty years ago, then filled with young people, are dead and have left no successors. It is true, some young people resort to the high schools and endowed academies, but secondary education here is far less general than in the former time, while many are lost to the college and higher education whom a good local academy of the old type would stimulate to an extended course of study. In one of the most picturesque districts of New Hampshire is an endowed academy that thirty-five years ago had an annual attendance of more than four hundred, and sent to college each year thirty boys, to say nothing of a dozen girls as well and widely trained for whom no college opened its doors. The same school has less than one fourth the old number of students and graduates. It is fair to say that the decadence of this school is partly due to the larger advantages offered by better-equipped rivals, but the main cause of decline is the dearth of young people in its natural region of supply, and the diminished interest in higher education.

6. Many churches have dwindled into insignificance, or have been blotted out altogether, owing to deaths and removals, with no

corresponding additions. In scores of towns houses of worship are closed, to all appearance finally, or are used for non-religious purposes, while others are in the hands of Catholics, or are too far gone to decay for occupancy of any sort. In many towns enough church members in substantial doctrinal accord might be found to form one strong and influential church but for minor points of doctrine and practice, and so, divided, they live at a dying rate, of little consequence to their adherents or the community. The whole truth would not be told if it were not added that this religious desolation is also largely due to lack of sufficient interest on the part of members and outsiders to support church work and attend religious services. Not that the faith of the fathers is repudiated for newer or more liberal ideas, but that apathy on the whole subject is often the prevalent spirit. The home mission societies regard some of these towns in as much need of missionary work as the rudest frontier settlements.

7. I am told by persons who have spent their lives in these rural towns that there is a decline in public spirit, and a visible growing away from the pure democracy characteristic of primitive New England. For example, the old school district is no longer a body politic in New Hampshire. A town committee manages all school affairs.

All the statements of this paper are particularly applicable to the large extent of rougher hill country of New Hampshire, Vermont, Massachusetts, and Connecticut, but in a lesser degree and with various modifications, to other districts remote from large towns. It is possible that some of these conditions may be improved when industry and population are rearranged and adapted to the changed circumstances, but I can not escape the conviction that the decline is permanent. Even if the late movement to attract Swedish immigrants to these abandoned farms is successful, neither we nor our successors will see here again a rural community of the old type—keen, active, intelligent, sturdy, and independent, of strong moral and religious fiber, an unrivaled capacity for popular government, and an inborn and inbred taste for hard work, plain living, and high thinking.

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A CONCEPTION of the rate at which facilities of communication have been developed during the past two hundred years may be obtained from the statement that in the seventeenth century it required fifteen days to go by diligence from Paris to Marseilles; in 1782, the time had been shortened to eight days; in 1814, to five days, by mail-post; in 1840, to three days; and in 1889, to fourteen hours. In 1830, the voyage from Marseilles to Algiers occupied ninety-six hours; in 1857, forty-eight hours; in 1877, thirty-eight hours; in 1887, twenty-eight hours; in 1889, twenty-four hours; and it is expected to be accomplished, by two boats that are to be built, in twenty-two hours.

## THE PRINCIPLES OF DECORATION.

By Prof. G. AITCHISON.*

WE have, in our cities, three things that are adverse to the embellishment of our lives: First, we live, as a rule, in hired houses. No one will ornament his house with that which is beautiful, permanent, and costly, if some one that he neither knows nor cares for will, after a few years, enjoy it, and that without paying one farthing as compensation for the outlay. Secondly, our clothes are not only ugly, but ignoble in form. Sculpture or statuary, when used to portray man in the costume worn in England, is impossible; the ablest sculptor can but turn out a scarecrow if he is bound to reproduce the actual clothes. Thirdly, in our buildings the atmosphere and its accompaniments almost forbid external color in monumental materials. Those materials that are unaffected by wet, frost, and the vitriol of the atmosphere, are soon covered with a pall of soot and dust. If we could once get Englishmen to love something beautiful, the fine arts might then enter on a new career. Our machinery and mechanical appliances could furnish almost the poorest houses with copies of first-rate works of art if the demand once arose. It is, however, much more important that the outsides of buildings should be enriched with color and lovely form than their insides. I may say that they are wanting in their first duty to the public if they are not beautiful, for they have not only taken some sky and air from us, and possibly flowers, trees, or herbage, but they help to poison the air by their smoke, dust, and exhalations.

In using decoration we are strictly following Nature, who not only makes the most of her works of beautiful form and of beautiful color, but enriches them with a variety of texture, of patterns, and of colors that would in man's work be most strictly decoration. No doubt some of this is protective, but much also, as far as we can judge, is purely ornamental.

The schemes for decoration are purely architectural, not only when they apply to buildings but also in the case of separate articles that are movable, and that are not wholly covered with one scheme of ornament, and for this reason, that architecture deals with harmonic proportions, and with the contrast of primitive forms.

What may be called formal ornament is the application of certain observed facts in Nature that please. Up to a certain point the repetition of some simple form is pleasing: lines are said

* Abridged from his lectures before the Society of Arts.

to be divided harmonically when they have certain ratios to one another, and spaces may have similar proportions, and these as well as certain curves give more pleasure than others; the combination of some flat and sharp curves is also found to be beautiful; the contrast of certain forms and of certain colors also gives pleasure. It is the application by man of these observations properly worked out to things he wants that makes them ornamental, and their superposition on elegant forms is said to decorate them. That which is the most perfect in ornament is the work of people gifted with high artistic fiber, and faultless execution, to whom Nature appeals in her masterpieces, who assimilate some of the matchless grace they see in a flower, in the turn of a leaf, in the curves that mark the growth of a creeper, in the wing of a bird, the curve of a lizard, or the knots or spirals of a serpent, who can so arrange these forms as to perfectly satisfy the cultivated eye, and keep them subordinated to the containing lines; such things may be seen in examples of Greek and Tuscan, or rather north Italian, ornament. This sort of ornament by some mishap has got christened *conventional*, a term which has no meaning as applied to ornament; it should rather be called *abstracted*.

Color is another species of ornament that, like form, has doubtless its laws, though as yet neither have been discovered, and we call form and color, like medicine, empirical arts. We observe that the collocation of certain spaces, or masses of certain colors, give us more pleasure than others, and we try and recollect these collocations if we deal in color, and use them when we have occasion. It has been observed that the primaries that are complementary—i. e., whose mixture produces white—go well together, and that certain secondaries and tertiaries set off primary colors. Chevreul found that the saturation of the eye with a color caused it to see the complementary color if a white surface was looked on; and Chevreul also found out that, if we looked at another color, it was modified by the complementary color of the first.

In choosing color we should be careful to have such a tone as we can live with, for most people have their dislikes and preferences. The color of a lady's boudoir is mostly chosen because it sets off her complexion. In a room where we work we are soon conscious of an objectionable color which irritates instead of soothing us. Certain colors and certain tones are beneficial or prejudicial to health. Very dark rooms are prejudicial, and red or yellow will also have a prejudicial effect on our health if we have to remain in rooms of either color all day and every day. A manufacturer had a women's workshop painted yellow, and found much more than the usual sickness among his hands. His doctor recommended whitewash, and the normal

health was restored. Growers of hyacinths have noticed a marked effect on their blooming when they are put in glasses of certain colors.

This age is a peculiarly health-seeking one, and it does not seek health, as the Greeks did, by early rising, temperance, open-air exercise, and training; but it asks how health can be preserved and promoted by the removal of external sources of disease, so that it may have freedom to infringe with comparative impunity Nature's laws. External poisons are the most important things to protect ourselves from, especially when we have enfeebled our bodies, and these are mostly conveyed to us by mephitic vapors and what the doctors call septic dust. We want our houses and other buildings so constructed that they can be freed outside from their palls of dust and soot by means of a fire-engine or a sponge, and inside by the broom, the dusters, and the flannels of the housemaid.

Foul and poisonous air has scarcely any connection with decoration, but, with one or two exceptions, is in relation with pure science and its applications. The exceptions are when some of the materials used for decoration have a pernicious chemical action on the air, or parts of their substance readily come off and poison us when we breathe, or when in contact with our skin. The former is said to be the case when preparations of arsenic and some other dyes and pigments are used and are not varnished. The dust that is not septic consists of minute particles of raw or cooked earth, stone, and metal, and the ill effect it may produce can only be from irritation of the mucous surfaces, by clogging fine vessels, or by getting into parts where it is not wanted. Particles of some metals, if numerous enough, may poison us, as fire-gilders are poisoned by mercurial fumes. The septic dust consists of particles of vegetable or animal fiber, sometimes laden with the germs of disease, the pollen of flowers, by some of which hay fever is said to be produced, the eggs of microscopic creatures, and microscopic creatures themselves. Another source of poisoning is by animal and human exhalations.

Anything that forms a dust-trap is as far as possible to be avoided, particularly when these traps can only be partially emptied at long intervals, for every breath of air dislodges some of the lighter particles. The absorbents of the foul-smelling exhalations have also the property of imparting them to damp air, by which we are poisoned or repoisoned. Consequently we want to avoid as much as possible all woven and felted stuffs in our houses, and to have all wood and paper protected by varnish.

Few of us can expect to live in houses built of polished granite, porphyry, and jasper, and adorned with precious stones, but we may expect to live in those protected and embellished with enam-

eled terra-cotta, glass slabs, or glass mosaic, and that our streets may at least present a clean, gay, and cheerful appearance.

I beg you to observe the Chinese, Japanese, and Persian pottery exhibited, mostly in the shape of tiles, and I ask you if these would not make a lovely alternative to our present fronts of dingy brick or plain or painted compo. When I was in Cairo, many house-fronts and some fronts of mosques were faced with these Persian or Rhodian tiles. If any one would start a gorgeous front of enameled pottery, there would be an outcry at first; but we should gradually get accustomed to beauty and color, and become reconciled to the loss of dingy and blackened brick. Even now there is no outcry when the platforms of a railway station are lined with white glazed bricks banded with green or gray, and the small extra cost would soon be repaid by better health and the saving of painting. At first this could only be done by tasteful, benevolent, and patriotic men who were wealthy, or by enterprising ones, who thought a house so fronted would advertise itself; but as this sort of facing came into fashion, window jambs and reveals, panels, strings, and cornices would be kept in stock, probably printed in colors instead of hand-painted, and would be cheap enough. There is one use of enameled pottery I have not mentioned—roofing tiles. In parts of France and Italy these prevail. At Lugo, in the Romagna, I saw the steeple of a church covered with enameled pottery of different colors, which wound round it, the steeple being a cone; the visible glazed parts were semicircular in section, and, though I do not know how they were fixed, they looked as if they were stuck into mortar, like the enameled terra-cotta cones found at Babylon, and used to ornament wall surfaces. Most of the tile patterns I have seen in France are, to say the least, more ingenious than beautiful; but there are gold and green tiles used at Vienna and at Botzen that are ornamental enough.

Even the Romans were more alive to the use that might be made of broken glass than we are, for we learn from Martial that the collection of broken glass was a trade, and the glass, he says, was exchanged for brimstone matches. I can not say how these glass slabs or tiles would stand our climate, but, if they could be fixed in no other way, they might be set in frames of cast iron, barffed.

I hardly know if I should include *sgraffito*. It would certainly be useless in the denser parts of London, as it would soon be a uniform dingy black; but we know that there are still examples that are visible at South Kensington, and that it lasts well in the country. It is done in this way: Any colored ground that may be chosen is first prepared of mortar or cement, colored with earthy or mineral pigments; it is then laid on the wall.

White, black, yellow, red, or gray are the usual colors. On one of these grounds, before it is dry, about one eighth of an inch of cement of one of the other colors is laid, the pattern is pounced on, and the parts outside the pouncing are scraped off with a modeling-tool, a knife, or a bit of stick. When the whole has set, you have a picture or a pattern in two colors. This sort of work has stood in England for over twenty years when executed in the country, and in Italy the whole fronts of many large palaces have been adorned in this way, and have stood for centuries.

Public buildings built of polished marble, granite, porphyry, jasper, agate, or onyx, or faced with these, are sometimes ornamented by inlaying pictures or patterns with colored marble or precious stones; but I do not know of any external example in England. This work is called *pietra dura*. The Taj Mahal in India is a celebrated example. There are plenty of slabs, basins, vases, paper-weights, and jewelry imported from India and Italy of *pietra dura* work.

All external work in calcareous marbles soon perishes in the atmosphere of London, whether plain or inlaid, and all incised work filled with mastic so soon gets blackened that to execute it is merely labor lost. The only other work that can be used externally is in metal. Iron rusts unless constantly painted, and almost all other metals turn black. Real block-tin, not tinned iron, is said to stand the climate of London, but of course does not lack its pall of soot. Iron plates tinned are much used in Switzerland for the covering of steeples, but even there they get rusty. Lead takes its own blackish gray, but, as it otherwise stands the climate well, I wonder it is not more used for ornamental purposes, as vases, statues, roof-crestings, and the like. When I was a boy, some plumbers' shops were ornamented with leaden statues, vases, and ornamental cistern fronts. Lead is still used for ornamental roof-crestings in France, often heightened by gold, black varnish, and color. Lead is still much used for ornamental accessories in Holland—or perhaps I ought to say, was once used. Up to a short time ago there were leaden statues and vases in the gardens of the stately mansions in Mark Lane, near the Tower of London; there are still some at Hampton Court, and they would do very well in the niches or on the pedestals of our red brick fronts, if we could not afford bronze.

It is unnecessary to speak of the ordinary freestones that weather in London, the sandstones, the brick, both cut and moulded, the red, yellow, or gray terra-cotta, for all these have more or less granulated surfaces that can only be cleaned by tooling or rubbing, but plaster has never of late, as far as I know, been even tried—I mean plaster of common sand and lime, or, what is still better, of lime and marble-dust. Vitruvius tells

us that old Roman walls covered with this material were so hard, so beautiful, and so finely polished, that in his time slabs of it were cut out and used for table-tops. In speaking of plaster, I did not mean compo, either Roman, Portland, or mastic, but that plaster that is made workable for modeling, which the Italians call *gesso duro*. It was once common in England; the "Peter Pindar," in Bishopsgate, is an example, or was an example a few years ago, and many admirable specimens still exist in our country towns. Some of the vaulted ceilings of Hadrian's villa, at Tivoli, now open to the air, are still adorned with it, the grace, freedom, and delicacy of whose modeling we still admire, although it was done at least seventeen hundred years ago. In few things has England declined more than in plastering, from the prevalence of casting, which allows the employment of the least skilled mechanic. Most of us have seen the magnificent ceilings of Elizabeth, James, and Charles I's time, on whose flowers, fruit, etc., you can even now see the grain of the plasterer's hand, and the holes made by his thumb to get shadow. Even in plastered ceilings of Sir W. Chambers's time, who died in 1796, you see beautiful work in high relief of fruit, flowers, and foliage, and I believe the skill did not die out completely till the end of the first quarter of this century. The infinite variety that hand-stamping produces would to refined tastes be worth the expense, for cast work is all alike.

It is highly benevolent to encourage skilled handwork, for you not only liberate the better sort from that mechanical work which frets and eventually destroys a man by its unvarying and unthinking monotony, but you encourage higher skill, and you allow a man to put his soul instead of his fingers into the work.

Do not suppose I am finding fault with those excellent materials, Roman and Portland cement, or even mastic; all I mean is that, as yet, we have found no way of using them ornamentally in London, except as imitation of stone and stone carving. If we had a pure atmosphere, the first two would be invaluable for inlaying, but in a very short time stone and inlay are indistinguishable from the general grime, and that, too, even when the inlay is black mastic.

In the present day, most of our internal plaster-work of any pretension is done in canvas plaster. A thin coat of fine plaster of Paris is brushed into the mold, very thin open canvas in strips is pressed into this, and brushed over with coarse stuff; the whole is then stiffened with slips of wood, attached to the backing with canvas and plaster; it is then dried in a hot room, and screwed up in its place, and can be painted on at once; its greatest merit is its lightness. The defects of canvas plaster are its want of flatness in the larger panels and of straightness in the cornices.

Bronze, though it becomes a blackish green, has this advantage for the decoration of buildings, that it can be reproduced as often as you please from the modeled clay of the statuary. You may, therefore, get through its means first-rate work at low cost, if the repetition is great, and its use may be called benevolent as well, for it does not condemn skillful men to the brainless work of constantly reproducing the same thing.

It is needless to speak of wrought iron, which can be made into any form you like, and of any size and thickness, from the stem of an anchor to a leaf, and chased or engraved, polished or lacquered, tinned or gilt. I am happy to say that wrought-iron work is receiving great attention again both from architects, painters, and iron-workers, and can be made nearly as well as it ever could. I think cast iron has been needlessly depreciated and needlessly neglected in this truly iron age. You can not get the fineness of bronze, and you can not chase it, but you can get really beautiful work done in it, and the wit of man can never be better employed than in using good materials at hand in the proper way—i. e., by only asking them to do what they can do readily and properly. As far as I know, the only real drawback to cast iron is its liability to rust. If Mr. Barff's process can be applied cheaply and will resist the attacks of the atmosphere for a long time, all we have to put up with is blackness, and, if the parts of a front we must have blank were filled in with glass slabs, you need have very little more black than you want.

Cast iron is a difficult material to use—I mean it wants to be calculated for its strength, it requires much thought to ornament, and everything, even to a bolt-hole, has to be settled beforehand, and, except there is much repetition, it is costly. Its neglect is greatly owing to this, that no one will pay for the extra skill, time, and trouble required of the architect, so this admirable material is almost ignored.

As regards marble, I can not quite agree with M. Charles Garnier, that "even when it has lost its polish it still looks like a shabby gentleman, and is not to be mistaken for a vulgar fellow in his Sunday clothes." Except in rainy weather, when the marble is temporarily polished by the wet, its unpolished surface, in my opinion, can not be regarded as worth the outlay; and I say this with hesitation and regret, for the exquisite harmonies produced by the decayed marble of St. Mark's was a thing to be remembered; still, as an architect, I can not reconcile myself to using a precious material merely to give a flavor when I know that, in giving it, it is going to decay; I might, perhaps, if I were a painter. But for the inside of a building marble is the richest material you have for the production of lovely color—music without words—painted as it is by Nature's hand, with every

tint and tone of delicacy and subtleness, and enlivened, too, by the wildest caprices of beauty.

The bar to its use in England is the damp, for when the air is full of vapor the marble condenses the moisture, which stands on it in drops or trickles down it. But as most houses and buildings are now warmed, this need not stand for much, and if we panel our rooms below with wood, there is no reason why the upper part should not be of marble. Marbles are of every hue except blue, for blue Belge is black and white, and blue Napoleon, or imperial, is but bluish gray; and brown is scarce, though we have rosewood marble and Californian spar. Marbles are found in most countries of the world, and there are such vast varieties in Europe that they can hardly be catalogued.

Great taste in color is requisite for the proper arrangement of colored marbles; at present no one cares to exercise this taste as a profession, as there is so little effective demand, and, in spite of the low tone of marble generally, it is much easier to make a vulgar or discordant arrangement than a strikingly good or harmonious one. The fashion of using white marble chimney-pieces, white marble bas-reliefs, white marble statues and busts in decorated apartments, is absolutely fatal to low-toned schemes of color decoration, and, as a rule, all gorgeous schemes of color are low-toned, and white must then be used most sparingly as a jewel. White can only be sparingly ornamented with morsels of full color, or very high-toned decoration must be used in conjunction with it, as this alone can sustain masses of white.

Considering the wealth of this country, which mainly goes in useless feasting, useless men and maid servants, useless carriages and horses, and hideous as well as useless clothes, I do not think those who will not use marble from poorness of spirit are included in the beatitudes.

As I am now on marbles, I may as well include mosaic pavements. These must be greatly restricted in so cold and damp a place as England. Few of us love to walk on a marble floor without shoes or stockings, as all would do in a warm or hot climate, but it can be used for the pavement of Protestant cathedrals, for hall floors, for the center aisles of churches, for conservatories, porches, terraces, and the like; and when we can afford it, porphyry is by far the best material for the patterns, as it only polishes by the friction of dusty boots, unlike marble, which roughens, and unpolished marble is not more attractive than stone. Plain geometrical and flat floral patterns are the best, in marble or pottery floor mosaic, for the smallness of the pieces rather helps the scale of the room or building, and does not ruin it like marble squares.

The objection to pottery as mosaic in floors is its softness, so

that it soon wears away under much traffic. Figure-pictures, for a floor to be walked on, are a mistake, though they may be used as a center-piece to be looked at from above, and be surrounded by plants or flowers; but nothing can be more appropriate for internal wall decoration than figure-subjects, or floral ornament in marble or tile mosaic; in either case it is permanent, and can be easily cleaned, and that in marble, at least, must be low in tone, for it can have but two colors of complete purity, white and black.

England has got rich these last sixty years by flooding the world with rubbish, so nothing can be more patriotic than having a piece of the best workmanship you can obtain put in your house, and by that I mean attached to the freehold, if it be your own, and let this piece be adorned by the hand of an artist, for his workmanship is transcendental, and, if possible, let it portray a noble example, or evoke a noble reminiscence, and be of such materials that it can not well be sold or destroyed for the value of the material.

## SKETCH OF ELISHA MITCHELL.

A MONUMENT of modest size and style, standing, in Yancey County, North Carolina, on the highest point of land in the eastern United States, marks the grave of the man who first determined, by measurement, the culminating point of the Appalachian range—a man, too, whose local fame as a student of natural history, a hardy explorer, and a teacher, was pre-eminent. Not the little obelisk of bronze—that only shows the exact spot where his body lies—but the mountain on which it stands, whose supremacy over all the peaks east of the Rocky Mountains he established, and in the exploration of which he lost his life, is the true monument of Prof. Elisha Mitchell.

ELISHA MITCHELL was born in Washington, Conn., August 19, 1793. His father, Abner Mitchell, was a farmer; and his mother, Phebe Eliot, was a descendant, in the fifth generation, from John Eliot, the Apostle to the Indians. His great-grandfather, the Rev. Jared Eliot, M. D. and D. D., for many years minister at Killingworth, Conn., was distinguished for his knowledge of history, natural philosophy, botany, and mineralogy, no less than as a sturdily orthodox theologian; was a correspondent of Dr. Franklin and Bishop Berkeley, and was awarded a gold medal by the Royal Society for a discovery in the manufacture of iron. Young Mitchell inherited many of the qualities of the Eliots, and particularly of this ancestor. At four years of age he acquitted himself with credit in a school exhibition. At a little later age he

was fond of collecting his playmates in a group and telling them what he had read in his books, or explaining the pictures to them. He was prepared for college at the classical school, in Bethlem, of the Rev. Azel Backus, D. D., afterward President of Hamilton College. He was graduated from Yale College in 1813, in the same class with Denison Olmsted, afterward his associate in the University of North Carolina, and with other persons who subsequently became conspicuously known. He was then engaged as a teacher in Dr. Eigenbrodt's boys' school at Jamaica, L. I.; in the spring of 1815 he took charge of a school for girls at New London, Conn., where he became acquainted with the lady who was afterward his wife; and in 1816 he was appointed a tutor in Yale College. While thus engaged, he and Prof. Olmsted were recommended by the Rev. Sereno E. Dwight, son of President Dwight, Chaplain of the United States Senate, to Judge Gaston, member of the House of Representatives from North Carolina, who appears to have been looking around for candidates as suitable persons for professorships in the University of North Carolina, at Chapel Hill. Mr. Mitchell was chosen Professor of Mathematics, and Mr. Olmsted Professor of Chemistry, to which a chair was then for the first time assigned. Having studied for a short time at Andover Theological Seminary and received a license to preach, Mr. Mitchell removed to North Carolina, and reaching Chapel Hill on the last day of January, 1818, immediately began his work as a professor. Here he remained, continuing at his post without intermission of considerable length, for thirty-nine years, or till the end of his life.

In the fall of the next year Prof. Mitchell returned to Connecticut to be married to Miss Maria S. North, daughter of Elisha North, M. D., of New London. The bride's letters describing her journey to North Carolina give some side-lights on the life and methods of travel of the time. The marriage took place on Friday, the choice of the day having been partly made as a demonstration against a popular superstition, and partly determined by circumstances. The journey of eight hundred and fifteen miles to Chapel Hill occupied ten days. On the removal of Prof. Olmsted in 1825 to accept a professorship in Yale College, Prof. Mitchell was transferred to the chair he had filled, and became, and continued till the end of his life, Professor of Chemistry, Mineralogy, and Geology.

Dr. Albert R. Ledoux, in a historical sketch of the University of North Carolina, published in the University Magazine for October, 1890, speaking of the intellectual giants in its faculty who have given reputation to the institution, and whose contributions to letters and science made them prominent among the learned men of their day, observes that Prof. Mitchell was the most noted

of them all. During his occupation of the chair of Mathematics, the doctrine of fluxions, or the calculus, was introduced into the course, and the standard of attainment was raised in other branches of the department. His transfer to the chair of Natural Science was welcome to him. Even while a Professor of Mathematics, according to Prof. Charles Phillips, he had made frequent botanical excursions in the country round Chapel Hill; and after settling himself in his new chair he extended and multiplied these excursions; "so that when he died he was known in almost every part of North Carolina, and he left no one behind him better acquainted with its mountains, valleys, and plains; its birds, beasts, bugs, fishes, and shells; its trees, flowers, vines, and mosses; its rocks, stones, sands, clays, and marls. Although in Silliman's Journal, and in other periodicals less prominent, but circulating more widely nearer home, he published many of his discoveries concerning North Carolina, yet it is to be regretted that he did not print more and in a more permanent form. It would doubtless have thus appeared that he knew, and perhaps justly estimated the worth of, many facts which much later investigators have proclaimed as their own remarkable discoveries. But the information that he gathered was for his own enjoyment and for the instruction of his pupils. On these he lavished, to their utmost capacity for reception, the knowledge that he had gathered by his widely extended observations, and had stored up mainly in the recesses of his own singularly retentive memory." The notes of his excursions, which are recorded in a series of blank books kept for the purpose, give revelations of the habits of the author's mind; they chronicle his walks over farms which he names, and observations of individual plants and other objects in specified localities. "By such a rock," writes Mrs. C. P. Spencer, in an article of reminiscences, "in such a field, is a plant that he must identify. By Scott's Hole, near the willow is a *Carex* that he must watch. March 29, 1821, he finds yellow jessamine in bloom in Mrs. Hooper's garden, and 'in great abundance on the creek below Merritt's mill.' . . . May 30, 1821, occurs this note, that he had that day found the last of the twelve varieties of oak that are within two miles of the university; then follows a list of the oaks and notes of their situation. . . . In the third week of April, 1824, he begins a new Diary of Mosses, and hunts the *Liskea hypnum* through a dozen authorities, to be sure of it. He had the true scholar's disdain of taking anything at second hand. Such pages are diversified with 'Hints for the good instruction of the class'; or, 'Points to be meditated respecting the nature of light.'" In the preface to one of these note-books—written in French—a plan of study was laid down for each week. So many hours were to be given to mathematics, so many to Latin

and Greek, so many to history, so many to the Spanish language and to botany; and the resolution appears that, till such an hour, "I will not touch one book of *belles-lettres*." He thus visited the plants and rocks of the State in their own homes, and became one of the best authorities in the country respecting them. The expeditions which he conducted into all parts of North Carolina, examining the flora and rocks and strata, made him the best physical geographer the State had ever had. The information he gathered in this way was used profusely in the instruction of his classes, and they always reaped greater benefits from his acquisitions, than any other part of the community. While he wrote occasionally for the scientific papers, "he read more than he observed, and observed more than he wrote." Among the articles contributed by him to Silliman's Journal are named, in a memoir published in the local paper at the time of his death, those on the low country of North Carolina, 1828; on the Geology of the Gold Regions of North Carolina, 1829; on Welther's tube of safety, with notices of other subjects, 1830; on the causes of winds and storms, 1831; Analysis of the Protogæa of Leibnitz, 1831; and notices of the high mountains in North Carolina, 1839. Such articles were contributed at intervals till the time of his death. He also prepared for use in his classes, a Manual of Chemistry, the second edition of which was passing through the press when he died; a Manual of Geology, illustrated by a geological map of North Carolina; and Facts and Dates respecting the History, Geography, etc., of Palestine.

Prof. Mitchell was an industrious reader, particularly on all subjects that were directly or indirectly connected with his professorship, and had a knowledge of geography that was regarded as wonderful. At a time when students were more isolated from one another than they are now, and facilities for exchange of news were not so abundant, he was at great pains to keep up with the advance on every side. With all this he was of conservative tendency, and not disposed to accept the new too hastily. As a teacher, Prof. Phillips says, "he took great pains in inculcating the first principles of science. These he set forth distinctly in the very beginning of his instructions, and he never let his pupils lose sight of them. When brilliant and complicated phenomena were presented for their contemplation, he sought not to excite their wonder or magnify himself in their eyes as a man of surprising acquirements, or as a most dexterous manipulator, but to exhibit such instances as most clearly set forth fundamental laws, and demanded the exercise of a skillful analysis. Naturally of a cautious disposition, such had been his own experience, and so large was his aquaintance with the experience of others, that he was not easily excited when others announced

unexpected discoveries among the laws and the phenomena which he had been studying for years as they appeared. While others were busy in prophesying revolutions in social or political economy, he was quietly awaiting the decisions of experience. He constantly taught his pupils that there were things wherein they must turn from the voice of the charmer, charm he ever so sweetly. His influence on the developments of science was eminently conservative, for he loved the old landmarks."

Prof. Mitchell's general fame rests chiefly on his work in the exploration of the Black Mountain of North Carolina, a spur which, standing between the main mountain ridges, had been regarded by persons best acquainted with the region, without knowing its exact height, as the culminating point of the Appalachian system. The two Michauxes had remarked, about the beginning of the century—the elder in 1799, and the younger in 1802—the presence of Alpine plants there that were not found again south of Canada, and inferred that the peak must therefore surpass all its fellows in height. John C. Calhoun had come to a similar conclusion, from the observation of the streams that had their source on the mountain. Meeting the Hon. David L. Swain, who was afterward President of the university, in 1825, Mr. Calhoun congratulated him on being of the same height with Washington and himself, and on their both residing in the neighborhood of the highest mountain on the continent east of the Rocky Mountains. When asked the meaning of his remark, Mr. Calhoun referred to the map as showing that in this group were to be found the highest sources of one of the great tributaries of the Mississippi, the Tennessee; of the Kanawha, flowing northward into the Ohio; and of the Santee and Pedee, which run directly to the Atlantic—all considerable rivers finding their way to the sea in opposite directions. The story was told by Governor Swain to Prof. Mitchell in 1830, during an excursion on the Cape Fear River. Although Mr. Calhoun's reasoning was defective, his observation, coupled with the opinion expressed on other grounds by the Michauxes, impressed Prof. Mitchell, and aroused a desire in him to know more of the Black Mountain, and to determine its height. The opportunity came in 1835. The memorandum-book in which the notes of his visit in that year are recorded contains such entries as "Objects of Attention—Geology; Botany; Height of the Mountains; Positions by Trigonometry; Woods, as the Fir, Spruce, Magnolia, Birch; Fish, especially Trout; Springs; Biography"; etc. He was accompanied by his daughter, and carried "two barometers, a quadrant, a vasculum for plants, and a hammer for rocks." The incidents of this expedition, the details of which became important in the case of a controversy that afterward arose, have been summarized and confirmed by the testi-

mony of witnesses in an article which Prof. Charles Phillips contributed to the North Carolina University Magazine for March, 1858. Having made some observations of the geological formations of the Grandfather Mountain, and measured some heights near Morganton, Prof. Mitchell crossed the Blue Ridge and fixed his headquarters at Bakersville, in Yancey County, near the foot of Roan Mountain. Hence he made several excursions in a country which was then nearly in the condition of the primitive wilderness. Being told that Yeates's Mountain was the highest of the group, he climbed it, accompanied by two guides, on the 27th of July, 1835—a day so clear and serene "that all the main eminences of the Black were clearly visible." He found that this mountain was overtopped by several of the peaks around it, the most of which confronted him in an arc so curved that it was easy to decide which of them was the highest. He made the entry: "Top of Yeates's knob; N. E. knob of Black bore N. 46¾ E. Counting from Young's knob: one low one; one low one; two in one, the southernmost pointed; a round knob, same height; a double knob; then the highest; then a long, low place with a knob in it; then a round three-knobby knob, equal to the highest, after which the ridge descends." This verbal account tallies exactly with a profile of the range drawn by Prof. Guyot when standing on the same Yeates's Peak in 1856. On the next day, July 28th, Prof. Mitchell and his guides visited the peak which had been determined by the Yeates's Mountain observation to be the highest; according to the testimony of the guide, William Wilson, they "came to the top at a small glade, not more than a quarter of an acre in extent, and, turning to the right, not more than one hundred and fifty yards, we arrived on the top of the main highest peak, being the same one as we thought that we had selected from Yeates's knob the day before. Then Dr. Mitchell climbed into the highest balsam he could find, and took his observations. After consulting his barometer, he said that it was the highest point that he had found yet."

Some of the immediate results of the excursions from Bakersville, including geological and botanical observations, were published in the Raleigh Register of November 3, 1835. The height of the mountain was calculated as compared with that of Morganton, which was then supposed to be 968 feet above the sea. The mountain being found to be 5,508 feet above that point, its height was given as 6,476 feet, or 200 feet less than the real height. The discrepancy became afterward a source of confusion, and has been used to support the allegation that the peak Dr. Mitchell climbed that day was not the real highest peak. But it was explained and vanished when the railroad surveys showed that Morganton depot is really 1,169 feet high. This would make Prof. Mitchell's

real measurement 6,677 feet, nearly what he obtained (6,672 feet) in 1844. Prof. Guyot, in 1856, obtained a height of 6,701 feet.

Doubts afterward rose in Prof. Mitchell's mind whether the peak he climbed in 1835 was the true summit of the mountain. A new measurement of Mount Washington had been made, which seemed to add to its reported height and lift it above Mitchell's Peak. Dr. Mitchell revisited the mountain in 1838, and determined in 1844 to make a new survey and measurement. He obtained a Gay Lussac mountain barometer from Paris, took William Riddle as his guide, and, making Asheville his base for comparison, found the height 6,672 feet. The identity of the peak visited this time was afterward called in question by other parties, but Prof. Mitchell himself never doubted that he had been on the right spot. He wrote in the summer of 1856, "I stood upon the highest peak some days since, and could then distinguish the ridges over which my guide, William Riddle, taking as nearly as he could a straight, or, as it happened, a diagonal direction across them from the neighborhood of the Green Ponds, led me directly to the peak we were in search of."

After the survey of 1844, the Hon. Thomas L. Clingman put forth a claim to having been the first to measure the real culminating point of the Black Mountain, and undertook to prove that Prof. Mitchell had been mistaken in the mountain which he measured. The question thus raised was the subject of an active controversy for several years. The highest mountain was called Clingman's Peak, and Prof. Mitchell's name was transferred to the peak which was described in his diary of 1835 as "a round three-knobby knob, equal to the highest," which he had never assumed to climb or to measure. It was as much to settle this dispute as for the sake of more accurate measurement that Prof. Mitchell made his fifth visit to the mountain in 1857, in which he lost his life. The question was investigated by his friends after his death, when all the accessible evidence was collected and compared, and his priority in measuring the peak, and the identity of the mountain he measured in 1835 with the real highest point, seem to have been satisfactorily established. In evidence to support his claim, Prof. Phillips brought forward the notes in his diary of 1835 and their exact correspondence with Prof. Guyot's profile; the testimony of William Wilson, one of the guides who went up with him, and who gave in his certificate a correct description of the topography of the summit, and of Nathaniel Allen, son of Adoniram Allen, the other guide, deceased, who said that his father had always spoken of that peak as the one which he ascended with Prof. Mitchell; the certificate of four citizens who accompanied William Wilson in September, 1857, while he retraced the steps of the ascent of 1835; the testimony of numerous

citizens respecting the landmarks and the geographical features, particularly of the streams, by which the true highest peak is located and identified; and the testimony of the same citizens that this peak was generally known through the country as Mount Mitchell or Mitchell's High Peak, while the other mountain (Party Knob) to which Prof. Mitchell's name has been attached was not so known till after the visit of 1844.

Prof. Mitchell's fifth visit to the Black Mountain, in 1857, was made in view of the controversy with Dr. Clingman for the sake of obtaining more careful and accurate measurements than he had been able to secure before, and for the purpose of investigating the value of the number which is used in calculating heights by barometrical observations. To this end he had provided himself with four of Green's Smithsonian barometers, and sent one of them to Savannah to be employed in contemporaneous observations by Dr. Posey at the level of the ocean and nearly on the same meridian as the Black Mountain. He further intended to connect the beach-mark on the North Carolina Western Railroad survey by a line determined by a spirit-level with the top of Mitchell's Peak. After marking off points differing in height by five hundred or a thousand feet, he designed to continue contemporaneous barometrical and thermometrical observations for several days at each of these points, and thus obtain reliable data for a full discussion of questions concerning measurements by barometer in the latitude of the region. He began the survey about the middle of June. On the 27th of that month, when his work was about half completed, he separated from his son, with the intention of going across the mountain to the Caney River settlement to visit the Wilsons and Mr. Riddle, his former guides, and securing their assistance in identifying points which they had visited together. He was never seen alive afterward. A storm arose that evening, in which he probably perished. When it was found that he had neither reached Mr. Wilson's nor returned to his lodgings, parties started in search of him. As the search continued, and the news spread that he was missing, the parties grew, and soon included a considerable part of the mountain population of Yancey and Buncombe Counties; for the people were all warmly attached to him. His trail was found and followed to a point where the guides declared, from its irregularities and the evidences that the wanderer had become no longer able to pick his course, that darkness had overtaken him; thence along a small creek to a place now called Mitchell's Falls; and there, on the 7th of July, the body was found in the pool below the falls. The marks on the bank showed that Prof. Mitchell had slipped forty-five feet down the slope and then fallen fifteen feet into the pool. The body was borne by the Yancey men, after the coroner's inquest, a dis-

tance of about three miles, to the top of the mountain. Then word came that it was to be taken to Asheville; and the men of Buncombe took it up and carried it there.

Not quite a year afterward, in June, 1858, the body was exhumed from the graveyard of the Presbyterian church in Asheville, and was carried again, this time with formal ceremonies, and a procession of citizens, large considering the character of the march, to the top of the mountain, where it was laid in the earth, within a few feet of the famous balsam tree. A funeral discourse was pronounced by Bishop James H. Otey, D. D., of Tennessee, one of Prof. Mitchell's first pupils, and an address in vindication of Prof. Mitchell's claims to have the mountain named after him was delivered by President Swain. It is worthy of remark that the first class taught by Prof. Mitchell in the university was represented at the ceremonies, in the persons of Bishop Otey and Dr. Thomas H. Wright, of Wilmington, and the last class by Mr. J. W. Graham and his own son. A monument, twelve feet high, in the material known as white bronze, was erected over the grave in 1888.

The question of the name of the mountain appears to have been decided by the United States Geological Survey in 1881–'82, which, adopting the final designations for the peaks of this range, gave Prof. Mitchell's name to this one.

Prof. Mitchell was a Presbyterian minister of the Presbytery of Orange, Synod of North Carolina, and was styled, in the memorial resolutions passed by the synod, probably the most learned man that had ever lived in the State; was a regular preacher in the college chapel and the village church; and was the college bursar, a justice of the peace, a farmer, a commissioner for the village of Chapel Hill, and at times its magistrate of police. He was known as a skillful and conscientious professor, and vigilant, long-suffering, firm, and mild as a disciplinarian. Believing that prevention of the ills of a college life was better than having to cure them, he was watchful to guard the students against falling into error. When offenses were committed, he would try to present the nature of his conduct to the culprit in its true light, and, when punishment had to be inflicted, to select such a method as would appeal to his better feelings and open the way to a return to sound views. He loved to help others, and he was a well-grounded believer in revelation. He was extensively known among the mountaineers, who all had a remarkably warm affection for him, and the interest that was aroused among them by the circumstances of his disappearance was still "warmly alive," and the event was still a topic of conversation among them, as late as the end of 1889.

# CORRESPONDENCE.

## INDIVIDUAL ECONOMICS.

*Editor Popular Science Monthly:*

IT has been again and again stated, by good authorities, that the American people are the most wasteful upon the face of the earth; they do not utilize to any extent their health, strength, money, or talents. To any thoughtful mind there is evidence of this on every hand.

We might naturally suppose that our many excellent modes of teaching, from pulpit and teacher's desk, would eradicate this evil; but, on the contrary, the accessories of our churches and schools become more extravagant every year, and there is less to be hoped from them. There are many ill-balanced minds among the youth attending our schools. These, with their intellectual tastes aroused, leave school very poorly equipped to battle with the exigencies of modern life; consequently, many of our so-called educated youth become stranded as embezzlers in State prisons or patients in insane asylums.

When we study the causes which lead to the great amount of wretchedness, poverty, and crime in our land, it is evident that good effects would result to our people if every child could be taught to see the wisdom of properly economizing health, strength, money, and talents. In order to do this, public opinion must first be converted. People must realize that such men as George Bancroft, the historian; Robert C. Winthrop, the statesman; and William W. Corcoran, the philanthropist, and other noble octogenarians, could never have attained their great age and to such positions of honor among their fellow-men save by great self-denial and economy. To be sure, the law of heredity comes in to aid some persons; but do you not think, if the principles prevailed which governed the early life of Whittier and the frugal homes of New England, that each succeeding generation would reach a higher plane in social life? We expect certain intellectual results from public-school methods; why not expect moral benefits to the child's character as well? There are many teachers who strive for this, like wise Mark Hopkins; but the field of education is so extensive, and the attention of educators is so absorbed in other matters, that little attention is given to individual economics. Do not understand me to desire the inculcation of penuriousness among our young people, but simply wisdom and moderation in all our affairs. It has been customary at some boarding schools to have printed upon the plates from which the pupils eat such sentences as "Waste not, want not." Such are not the means that I would urge for teaching economy, but that our leaders in society, on the press, in the pulpit, and all teachers, should unite to enforce the great principles of economy and moderation by example and throughout all their teachings. Even teachers of natural history can bring their instruction to bear upon this point, from the innumerable instances of economy in nature.

When a colored girl in Washington replied to a reprimand for being late at school that the cook was absent and her mother was sick, and of course *she* could not get the breakfast, it showed the lack of thrift and right management in that household. She would have been ashamed to make that reply if the influence of her home and her school had not left her blind to the dignity of labor and the honor to be derived from doing one's duty.

We very well know that college life is the hot-bed of extravagance, and that no great and united effort has been made to repress this wasteful tendency. It is to be hoped that when our great institutions of learning have become financially endowed so that they are perfectly independent, they may be able to take some means to turn the tide and set a fashion of economy and moderation.

Investigation shows that our poorest classes are the most extravagant. On market-days we find that those persons who carry their entire fortunes in their hands will purchase the highest-priced provisions, which are often the least nourishing. If we could have savings-banks in our schools, as in England, our people who earn good wages could learn to accumulate. Millionaires tell us that it is the first thousand dollars which is the hardest to earn—interest then increases of itself. Have we not all had the experience of helping people who would not help themselves, but would, by lack of self-denial or even moderation, keep open some leak by which their misfortunes were continually on the increase?

Would there be so much temptation to anarchism and crime if our working classes understood the right principles of living?—if they understood that fortune and success are generally to be obtained only through systematic living and often great self-denial?

It is probable that our workingmen would not spend so much time and money in restaurants if they could obtain well-cooked food at home; therefore, cooking schools are a great help to economy.

That early training in thrift and mod-

eration is much needed by our girls we have fair evidence among women in Washington, where so many are stranded without homes, friends, or fortune. Sixty women have been known to apply at a private school as teachers during the summer months, and most of them ill fitted for earning their living in any position. The political changes in Washington conduce strongly to this state of affairs. It is well known that great improvidence exists among the families of the male and female clerks in the departments in Washington as to their manner of living. Many a clerk receiving eighteen hundred or two thousand dollars a year will die, after twenty years or more, without having saved a cent, even for his own funeral expenses, leaving a family with extravagant habits to battle with the world as best they can. This is no uncommon case; to be saving and buy a home is the exception.

I can only give out a few hints on this great subject; but I venture to hope that reflective minds may be impressed with its importance, and may exert their influence to encourage the teaching of the underlying principles of economy and moderation to our children in the public schools.

LAURA OSBORNE TALBOTT.

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## THE BASIS OF MORALITY.

*Editor Popular Science Monthly:*

SIR: I have read Herbert Spencer's The Data of Ethics, and, if I have not misunderstood the work, it teaches that the object to be gained by pursuing morality is happiness, and that a nation's happiness increases as does its morality. If by the term happiness we mean surplus of pleasure over pain, I think that the happiness of savage nations is greater than that of civilized ones. The former are certainly healthier. By our definition this fact alone indicates greater happiness. But savage nations are notoriously immoral. People, whether religious or not, when they argue against immorality, generally give reasons for its avoidance which issue from the heart and sentiment rather than from the mind.

Here are some instances: We say that a man who has been a miser all his lifetime is wretched and unhappy; yet he may have been in perfect health, bodily and mental, which we must assume to indicate that he has been able to exercise all his faculties: and the exercise of faculties, according to Spencer, constitutes pleasure. Persons unable to stick to one occupation for any length of time are often spoken of in terms of pity, yet they also may have led lives of perfect activity. In the former case the means by which the miser accumulated his fortune are held up to us as directly causing pain to the user of them, and we are warned not to follow his steps, for he must have suffered. In reality, however, he could not have suffered so terribly, for if he had he would not have been left in the possession of the power to exercise all his faculties. By similar reasoning we can come to a like conclusion in regard to the vacillating kind of people I have spoken of. People make a mistake in looking at such things through only their own eyes.

An instance of the opposite kind in behalf of the pursuit of morality is as follows: After hearing the biography of two persons, one of whom led a long, healthy, selfish life, and the other, having all the advantages of education, was possessed of a sympathetic and an emotional nature which recognized and met the wants of others, and who during his lifetime was universally loved but constantly suffered, most of us would prefer the life of the latter.

With the idea of happiness in mind we started with, I think the above instances show that the cultivation of morality is not necessarily accompanied by increased happiness. Now, if what I have said is true, it seems to me that the logic of the book in question is destroyed, and that all those who are interested in the furtherance of morality and the scientific discussion of ethics are obliged to face a disagreeable conclusion. It is this: Philosophic thinkers can really give no adequate reason for the pursuit of morality, and they, too, as well as professed believers in other-world motives for doing right, must often argue from the heart and according to their ideals and not as inexorable reason and logic demand; and must be content to live somewhat under a contradiction. I use the word professed not unthinkingly, as I believe that most really honorable people find their motives for rectitude in the present life.

To the possible objection to my argument that I have forgotten to take into account the increase of complexity of the pleasures which takes place as an organism becomes more moral, I may say that so do the pains become more complex.

I might also ask the question, Which pleasures are the greater, the simple ones of childhood, or the complex pleasures of maturity? It seems to me that there is no difference.

K.

SOMERVILLE, MASS., *November*, 1890.

# EDITOR'S TABLE.

### *THE EVOLUTIONARY VIEW OF MORALITY.*

OUR correspondent "K.," whose letter we publish on another page, is in serious trouble over the difficulty he finds in reconciling the view of morality given by Mr. Spencer, in his Data of Ethics, with the facts of real life. Mr. Spencer, as "K." understands him, teaches that "the object to be gained by pursuing morality is happiness"; while facts teach that morality sometimes calls for the sacrifice of happiness. Mr. Spencer strives to base morality on a foundation of reason, whereas experience seems to prove that it must to a large extent be based on sentiment—that, unless there is a heart impulse toward morality, there will be a lack of power to do the right, except in so far as it may also be the convenient. Therefore, as philosophy does not deal with or control the heart, it fails to furnish any adequate reason for the pursuit of morality.

Our correspondent has done well to express in plain language the thoughts that trouble him, and that such thoughts should trouble him is a sign that his own moral nature is in a state of healthy activity. We hope, however, to be able to show that the evolutionary system of ethics is not in conflict with experience, and that it renders important help to the cause of morality by giving a clear and consistent idea of what morality is. It is a mistake to suppose that it does much more than this. It does not claim to supply any incentives to right action, or any dissuasions from wrong action, other than may be found in a consideration of the consequences which such actions entail. We do not ask the physician or the hygienist to provide people with motives, beyond what the facts they state may furnish, for seeking health or avoiding sickness; yet no one, we think, will question that the diffusion of sound medical and hygienic information has an important effect in promoting the health of the community. The probability is that "K.," like many others who are feeling their way to the scientific standpoint, is still more or less under the influence of moral systems which bring the *sanctions* of conduct into far greater prominence than the essential nature of conduct. Systems that do this, and that place their sanctions mainly in another world, do much to retard the proper definition of morality. While men's minds are strongly occupied with the thought of rewards and punishments beyond all human measurement, the only question that seems to have any pertinence is, How am I to secure this infinite reward? How can I hope to escape that terrible penalty? The overwhelming character of the sanctions compels unquestioning submission to whatever code of morals may be promulgated in connection with them; and future systems of morality come to be judged, not so much by the nature of their ethical teaching, as by the motives they bring to bear in support of it.

This, however, we maintain, is not the right point of view. The business of a moral system is to define morality, not to enforce it; to trace the consequences and relations of actions, not to supplement deficiencies in the general scheme of things. If the decay of arbitrary sanctions leaves certain individuals unprotected against their own lawless tendencies, we can not be altogether surprised, and should not be unduly discouraged. No change, political, social, or intellectual, finds all persons equally prepared to meet it. The wise are those whose lamps are trimmed and fed, and who can light themselves to a place of light; the foolish are those

whose lamps are empty and untrimmed, and who, on a sudden call, can only stumble about in darkness. Evolutionary ethics are not discredited because there are those whose imperfect moral development craves inducements and restraints of a more imperative nature than any system which appeals merely to reason and good feeling can supply. "But why," our correspondent may ask, "do you bring in good feeling? My complaint is precisely that, while the evolutionary system professes to dispense with feeling, it does not and can not really do so." We know this is a common idea, but it is not a correct one. Feeling arises when habits have become so consolidated that their origin and justification, if not forgotten, are at least overlooked, so that they seem to be, as it were, self-justified. Feelings and prejudices are of kindred nature: where there is feeling there is, generally speaking, prejudice; where there is prejudice there is always feeling. In feeling we have the stored-up energy of repeated perceptions, and it acts as a fly-wheel to carry us past many a dead point of balanced calculations. The evolutionist shows that moral actions are those which specifically tend to produce happiness—to make life as a whole not only worth living but capable of being lived, if we may be allowed the expression. We all want life, and we want it more abundantly. Evolutionary ethics show how life in general is promoted and enlarged by certain acts, how it is impeded and straitened and undermined by others; nor can there be any reasonable doubt as to the validity of the classification thus established. Mr. Spencer does not say to each individual, "You will in every case find your personal happiness promoted by every moral act you may perform, and the more moral you are the happier you will surely be." He might, however, say: "In performing any moral act from a moral motive you will be sure to reap a certain satisfaction—the satisfaction that comes from having placed yourself in harmony with a law that you feel to be universal in its application; but whether," he might add, "your happiness as a whole will be promoted will depend upon how far in your particular case such satisfaction outweighs any loss or suffering which the performance of the act may entail. That is not a question that can be settled on general grounds; it depends on an equation in which your own moral nature as at present developed is the most important element." In order to determine whether an act is a moral act, what we have to do is to fix its relation to life as a whole, its specific tendency to promote or diminish happiness. To trace its thousand possible incidences in individual cases would be beyond human wisdom, and would be of little value if accomplished. To appeal to right feeling—to come back to a point that ought to be made very clear—is to appeal to a force that we know to have been accumulated through the performance of right acts—acts which, each in their own hour, have yielded up to the moral nature the satisfaction that comes from right conduct, and thus furnished a fund of virtuous impulse for future use. Far, therefore, from there being any incompatibility between the sanction of reason and the sanction of feeling, the two are but one sanction; the only difference being that one is special to the act at the moment under consideration, while the other is the great closed register of past moral judgments.

Of course, it is open to any man to say: "There is no morality in my composition, no feeling or prejudice in favor of what you call right courses of action, no perception of anything as desirable that does not make for my personal gratification; and therefore to me your scientific morality is equally without meaning and without authority." A man who spoke in that way would probably libel himself; but, in so far as we assume that he speaks the truth, we

have to admit that he is a more suitable subject for a severely authoritative *régime* than for any system of intellectual and moral liberty. Such a man doubtless needs the most alluring inducements on the one hand, and the direst threatenings on the other, to keep him from frequent transgressions. Not that the transgressions themselves would not in many cases entail punishments which, had they been foreseen, would have deterred him from misconduct, but simply because when a man is so constituted that, without any prepossession in favor of right-doing, he calculates over again on each occasion the probable consequences of a given act, the voice of present passion or desire is very apt to dominate all other pleas. Such a man is a mere moral pauper, starving himself on "beggarly elements," instead of nourishing himself and building himself up on well-developed moral principles. Long before Mr. Spencer, the English philosopher Hobbes dealt very well with this point. "The fool hath said in his heart there is no such thing as justice; and sometimes also with his tongue; seriously alleging that, every man's conservation and contentment being committed to his own care, there could be no reason why every man might not do what he thought conduced thereunto; and therefore also to make or not make, keep or not keep, covenants was not against reason when it conduced to one's own benefit." After thus stating the case of "the fool," Hobbes goes on to point out that such a man takes up a position of hostility to society, and therefore "can in reason expect no other means of safety than what can be had from his own single power," and "can not be received in any society that unite themselves for peace and defense, but by the error of them that receive him." His conclusion is that "justice is a rule of reason by which we are forbidden to do anything destructive to our life, and consequently a law of Nature."

The fool who says in his heart that there is no such thing as justice is generally enough of a knave not to say it aloud; and so far he pays homage to what he recognizes as a settled conviction of mankind. The science of ethics teaches us how conduct becomes ethical in its character, through what successively higher stages it passes, and wherein a true moral equilibrium consists. It can do no more. It is for every man to determine for himself how far he is influenced or means to be influenced by the knowledge that certain courses of action make for the elevation of his own character and the benefit of the world, while others make in an entirely opposite direction. If any man declares that such a manifestation of the truth influences him not at all, it would be well for him to seek the restraints and persuasives of some other system; or, if he means to enter upon a war against society, to take his measures with the greatest caution. It is some satisfaction to think that, among those who take the scientific view of ethics, there is rather more inclination of the heart toward what is right than among those who reject that view chiefly on the ground of its too feeble sanctions. "K." himself seems to admit this, and, if so, we do not see why he should feel discouraged. In conclusion, we may say that, if we have not fully met our correspondent's difficulties, we shall be happy to return to the subject, and deal as specifically as possible with any point he may suggest for discussion. We say this, not because there are not many other questions claiming attention, but because we are strongly convinced that there is not to-day a more important issue than this of the soundness and sufficiency of the evolutionary view of ethics.

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### *CULTURE FOR ITS OWN SAKE.*

THIS is a thing a good deal talked about, but which does not bear very close investigation. All work, all effort must have an object; otherwise it is not determined to any end, guided in

any definite channel, or impressed with any distinct character. The culture of the mind, like the culture of a field, must have an object. We cultivate the field that we may get better crops from it; we cultivate the mind that it too may yield better fruits. Nature in its spontaneous workings gives us the starting-point in both cases. She supplies the wild varieties of grain and other vegetable food, and man by his art improves her gifts, rendering them more adapted to his own special needs. In like manner the mind spontaneously working, without any thought of culture or training, lays hold of the facts which Nature presents to the senses and interprets them from its own standpoint. As the interpretation becomes wider through experience, new facts come into view, and knowledge and thought increase with even step. The object of all culture is, therefore, or should be, to give the power of broadly interpreting the data of sense, to place the individual in the most advantageous position possible for understanding the world in which he lives, and exerting a useful action upon some part of it. A culture that is severed from all ideas of utility is something altogether empty and nebulous; we may go further and say that it is something that tends to corruption. What does the decay of societies through luxury—that staple and by no means unreal theme of moralizing historians—mean, if not the corruption that comes of divorcing culture from service? Knowledge grows, art develops, wealth increases; and men forget that these should have a social destination and not merely be made ministers to pride and vanity and lust. For want of a healthy outlet for these forces a process of social decomposition sets in, and another page of history draws to a close.

Every man and woman, therefore, who seeks culture should seek it with reference to some definite aim in life, and not to make it serve as mere intellectual finery. The time has not yet come when we can safely intermit our efforts for the improvement of the social state; and all gifts and accomplishments can be pressed into the service of mankind, if only the motive for so employing them be present. It is when we consider our talents or our knowledge as serving only for our own glorification that they spoil on our hands. What more pitiful can be imagined than the small jealousy which is often found animating literary, artistic, and even scientific circles? It is hard to say whether the mutual admiration or the mutual depreciation of certain devotees of culture is the more ridiculous. All this comes of the "culture for its own sake" theory. Give culture an ulterior end, and it is at once ennobled and justified. The scholar, the man of science, the poet, the painter, the sculptor, the musician, will pursue their several tasks with no less devotion or success for thinking that, however little their work may be comprehended by the world at large, there is that in it in which even the world at large has a practical interest. If a man can not think this—that is to say, can not think it truly—then his work does not make for culture and might profitably be abandoned. Man lives by his faculties; culture is the enlargement or improvement of faculty in one direction or another, and makes thus for fuller life and deeper correspondence between the individual and the world. Governed by a social motive, it will seek to extend its benefits to all—as an ultimate aim—and will thus be kept fresh, vigorous, and pure. Governed by a selfish motive, it will degenerate into mere self-pleasing, affectation, and insincerity, and will never be far removed from moral corruption. The distinction is easily seized, and may profitably be taken to heart.

# LITERARY NOTICES.

CIVIL GOVERNMENT IN THE UNITED STATES CONSIDERED, WITH SOME REFERENCE TO ITS ORIGINS. By JOHN FISKE. Boston and New York: Houghton, Mifflin & Co. Pp. xxx + 360.

IF not the most important book that Mr. Fiske has written, this is, without doubt, one of the most useful. The plan of it is good, the spirit of it is good, the execution of it is good. Lucid arrangement seems to come naturally to Mr. Fiske, and to lucidity of arrangement he is always able to add extreme felicity of expression. With this book accessible to him, no American, young or old, can have any excuse for remaining ignorant of the leading facts in connection either with the political development or the existing political structure of his native country. Here we have the story told in the simplest language, and in a style which is not too vivacious to be serious nor too serious to be vivacious. Moreover, by a happy art in selection, Mr. Fiske has told us just what it is most important to understand and remember. His task is one of narrative and exposition; and he is not, therefore, called upon to any great extent for the expression of his individual opinions. Here and there, however, he has found occasion for a judicious comment or a penetrating criticism, with the result of making us feel regret that his limits did not permit more extended remarks of this character.

In the first chapter he deals with government as the taxing power, and broadly states that the taking of taxes for a wrong purpose, as by a political party in order to strengthen its hold on power, is robbery. In his second he sketches the rise of the township, and shows the connection existing between this primary political unit and the church congregation. The important functions exercised by the township authorities are fully described, and justice is done to the politically educative effect of township institutions. Very instructive parallels are drawn between the institutions of the parent state and those established on American soil. Except the development of our written Constitution, every bit of civil government described in his pages came to America, says Mr. Fiske, "directly from England, and not a bit of it from any other country unless by being first filtered through England." Much detailed information is given as to the local circumstances which helped to mold the development of counties and States in different parts of the country. Chapter V, on "The City," is most important. Here, again, our author takes us to the old land, and shows us the development of the Roman camp or military settlement into a burg, and the gradual growth in the burg of principles and traditions of liberty, though in many of them oligarchical tendencies became manifest in course of time, giving rise to the "rotten boroughs" which, on the political side, were dealt with by the Reform Act of 1832, and, on the civic side, by the Municipal Reform Act of 1835. It was the constitution of the English city or borough that determined the constitution of the first city governments established in this country; and here, too, a distinct tendency toward oligarchy, with its attendant evils, began to make itself felt. The city government, instead of being freely elected by the people, was, after the pattern of the English borough, a self-perpetuating corporation with a very limited responsibility to the citizens in general. In course of time this system was abolished; freedom of election for all city officers was established; and then, unfortunately, other evils set in, evils which perhaps reached their height in this city some twenty years ago. The tendency of late years in our cities, as Mr. Fiske points out, has been to concentrate larger powers in the hands of the mayor, and to fasten on him a proportionately heavy responsibility. "A hundred years ago," the author remarks, "our legislators and Constitution-makers were much afraid of what was called the 'one-man power.'" To-day we are getting to be more afraid of the myriad-headed tyrant, with its manager, "the ring." Fifty years ago to have had so few elective officers as, for example, there are in the neighboring city of Brooklyn, and so many nominated by one man, would, we are told, "have greatly shocked all good Americans." To-day we feel that we are safer in the hands of one honest man of good judgment, who knows that the eyes of all the citizens are fixed on him, than in those of any body of elected officers, each with only a partial and more or less doubtful responsibility. Mr. Fiske

recalls one fact which should not be lost sight of, and that is the danger the finances of a city are sometimes exposed to, not from the votes of the poorer members of the community, but from the machinations of the richer, who have it in their power to bring the most corrupting influences to bear on city councils, with a view to obtaining grants for improvements quite unnecessary on public grounds, but eminently useful for increasing the value of private properties. Universal suffrage has not been the sole fount of our municipal troubles.

"The purification of our city governments," says Mr. Fiske, "will never be completed until they are entirely divorced from national party politics." This is a view which a leading newspaper in this city loses no opportunity to ridicule, but which we think founded in good sense. The matter does not admit of discussion here, further than to say that this is a subject on which the experience of England can be appealed to. As our author observes, "The degradation of so many English boroughs and cities during the Tudor and Stuart periods was chiefly due to the encroachment of national politics upon municipal politics."

The rise of our Federal Constitution is well and graphically sketched; and in a few words the distinction between the two great political parties is well established. It is pointed out that, whereas the tariff question was formerly debated as a constitutional one, the predecessors of the present Democrats holding that Congress had no power under the Constitution to impose taxes for the purpose of advancing or protecting certain industries, it is now debated on economical grounds alone. The former view of the matter, however, we venture to hold, has not lost its pertinence, and we are not without hope that the citizens of this free republic will yet see that the tariff question is one in which their liberties are at stake. Mr. Fiske, as might be expected, has placed himself clearly on record as a friend and advocate of civil-service reform. Of the historic declaration that "to the victors belong the spoils," he observes that "the man who said this (W. L. Marcy) did not realize that he was making one of the most shameful remarks recorded in history."

There are appended to the volume some valuable and interesting historical documents, such as Magna Charta, the Constitution of the United States, with its amendments, etc. At the end of each chapter is a set of well-chosen questions, adding not a little to the value of the book for educational purposes. Mr. Fiske has produced a work which can not fail to be widely read, and which will do much to develop a spirit of intelligent and high-minded American citizenship.

WILD BEASTS AND THEIR WAYS. By Sir SAMUEL W. BAKER, F. R. S., etc. London and New York: Macmillan & Co. Pp. 455. Price, $3.50.

SIR SAMUEL BAKER'S last book of hunting adventures is a model of its class. Its accounts of hunts are spirited and fascinating, being neither too much nor too little detailed. Moreover, it is not made up solely of the circumstances of killing certain animals in specified places. It gives, in addition, the results of a vast deal of highly intelligent observation in regard to the nature and habits of the creatures that have fallen to the rifle of this humane and cultivated sportsman, as well as of the domesticated animals —horse, dog, elephant, and camel—which he employed in different expeditions. Many incidents of an amusing nature are included, the telling of which affords play for the delightful wit of the author. The greater part of the volume is devoted to large game—the tiger, leopard, lion, bear, hippopotamus, crocodile, buffalo, bison, and rhinoceros. Other animals included are the boar, hyena, giraffe, and various species of the deer family. The opening chapter deals with the development of the rifle during the past half-century, embodying Sir Samuel's reasons for preferring the sorts of arms and ammunition that he has used for different game. Following this are three chapters devoted to the elephant and his ways when tamed, including his behavior when employed for hunting tigers, etc. In all parts of the book appear traits of the animals described which will be new to many even who are well read in zoölogy. It appears that the elephant, who is generally thought of as a slow and lumbering, bulky body, can kick with extreme quickness and naturally with great force. "This is a peculiar action," says our author. "As the elephant is devoid of hocks, and it uses

the knees of the hind legs in a similar manner to those of a human being, therefore a backward kick would seem unnatural; but the elephant can kick both backward and forward with equal dexterity, and this constitutes a special means of defense against an enemy, which seldom escapes when exposed to such a game between the fore and hind feet of the infuriated animal." In Sir Samuel's opinion, the intelligence of the elephant has been overrated. It has a wonderful power of learning, and hence can be taught to perform a great many acts on command, but it will never volunteer any service for its master. "There is no elephant that I ever saw," he says, "who would spontaneously interfere to save his master from drowning or attack. An enemy might assassinate you at the feet of your favorite elephant, but he would never attempt to interfere in your defense; he would probably run away, or remain impassive, unless guided and instructed by his *mahout*." Sir Samuel has evidently been fond of tiger-hunting, for he recounts many exciting adventures with this dangerous game, the incidents of which make up a very full picture of tiger character. He has also hunted the lion, though evidently with less interest, as he says that he does "not consider the lion to be so formidable or ferocious as the tiger." Bears he has hunted in Ceylon and in Wyoming. He apologizes for admitting the crocodile, which he numbers among "vermin," to a place with the other animals that he describes. But he makes a very interesting chapter about them, in which he states that he has slaughtered a vast number of these reptiles in revenge for their killing his men. "On one occasion," he says, "I killed a crocodile which, although not longer than twelve feet three inches, was very thick in the body; this was proved to be a malefactor by the testimony of two bracelets and a necklace, belonging to a missing girl, which we found within its stomach." Sir Samuel's chapters on deer-hunting take us through Scotland, India, Ceylon, and the Rocky Mountains, and are full of interest, though without the dangerous situations included in the earlier chapters. Besides the ways of wild beasts, something may be learned from this book of the ways of the human inhabitants of the countries in which the author has hunted. Judging, however, from the speeches he puts into the mouths of American hunters, he does not attempt to report conversations *verbatim*. In conclusion, some observations are given in regard to animals that have not been objects of his pursuit—monkeys, bats, wild asses, and camels. A number of appropriate full-page illustrations embellish the volume.

PREHISTORIC AMERICA. By the MARQUIS DE NADAILLAC. Translated by N. D'ANVERS. Edited by W. H. DALL. New York: G. P. Putnam's Sons. Pp. 566. Price, $2.25.

THIS valuable work was published in French in 1882, and the translation, modified and revised by Mr. W. H. Dall so as to "bring it into harmony with the results of recent investigation and the conclusions of the best authorities on the archæology of the United States," was first issued two years later. A popular edition of the translation is now brought out at less than half the price of the former issue. For the benefit of those who have not seen the book, we will say that it is a comprehensive work, describing the human remains and the relics of human workmanship that have been found in both North and South America. Besides the purely descriptive matter, discussions are introduced concerning the origin of man in America, the length of time that he has lived there, etc. Thus, the first chapter is a summary of the evidence tending to show that man lived in America with the mastodon and other gigantic extinct animals. The second chapter sketches the discoveries made in American kitchen-middens and caves. The next two chapters are devoted to the mound-builders and their works, and review the questions that the discovery of these remains has raised. In like manner the relics of the cliff-dwellers and of the denizens of the ancient *pueblos* are described. Passing from the United States southward, the author gives an account of the ruins of Central America, and finally records the evidences of ancient life that have been found in Peru. He then proceeds to draw conclusions from the material thus furnished in regard to the physique of the early men of America. The volume contains two hundred and nineteen illustrations and has an index.

THE VETO POWER. By EDWARD C. MASON. Harvard Historical Monographs, No. 1. Edited by Albert B. Hart. Boston: Ginn & Co. Pp. 232. Price, $1.

THE first number of what promises to be a valuable series of publications has been issued by Harvard University. It gives the history of presidential vetoes in the United States from 1789 to 1889. This record is introduced by an account of the origin in English and colonial precedent of that particular form of the veto power which is found in the United States. Different classes of vetoes are discussed in successive chapters, namely, those affecting the form of government, those affecting the distribution of the powers of government, and those affecting the exercise of these powers. A chapter is added on the constitutional points which have arisen concerning the operation of the veto power, and another on the development of this function during the completed century of our national history. Appendix A is a chronological list of all bills vetoed from April 6, 1789, to March 4, 1889, with dates and references to the journals of Congress containing the legislative histories of the bills. Five other appendixes contain similar lists and tables. The editor states that both the author and he have endeavored to make this work free from political bias, and that "the vetoes are condemned or approved upon what seem to us sound principles of constitutional law and political expediency, irrespective of the attitude of present parties."

INTERNATIONAL JOURNAL OF ETHICS. Vol. I, No. 1; October, 1890. Issued quarterly. Philadelphia, 1602 Chestnut Street. Price, $2 yearly; single number, 50 cents.

WE are confident that the world will profit from the founding of this magazine. It is designed to do work which must greatly aid the elevation of human character and the increase of human happiness. It is the successor of The Ethical Record, and it is more than this. The announcement states that the Journal will be devoted to the advancement of ethical knowledge and practice, and that it will not be the organ of any society or sect or of any particular set of opinions. The word International in its name is justified by the composition of its editorial committee, which consists of Felix Adler, Ph. D., New York; Stanton Coit, Ph. D., London; Prof. G. von Gizycki, Berlin; Prof. Fr. Jodl, Prague; J. S. Mackenzie, M. A., Manchester; J. H. Muirhead, M. A., London; and Prof. Josiah Royce, of Harvard University. The list of contributors already engaged has a still wider range. Seven body articles and a department of book reviews make up the contents of the first number. The opening article is on The Morality of Strife, by Prof. Henry Sidgwick, of Cambridge University, referring especially to wars. It has been said that the spread of altruism would bring wars between states to an end. Prof. Sidgwick maintains that little improvement would be secured until the predominance of good-will was complete; for, so long as any were wronged, those persons dominated by altruism would still be eager to fight, albeit in behalf of others and not for themselves. To the proposition that strife can generally be prevented by competent arbitration, Prof. Sidgwick objects that this "external" mode of solution can not be applied to all cases, and he thinks it inevitable that, "at least for a long time to come, every nation in the most important matters must to an important extent be judge in its own cause." Therefore "we must endeavor to be just judges." Prof. Felix Adler contributes an article on The Freedom of Ethical Fellowship, in which he states that it is the aim of the Ethical Societies "to unite men of diverse opinions and beliefs in the common endeavor to explore the field of duty," and "to embody the new insight in manners and institutions." Prof. Adler says further: "Ethics is both a science and an art. As a science its business is to explain the facts of the moral life. In order, therefore, to improve it as a science it is necessary, before all, to fix attention on the facts, to collect them, to bring them into view, especially the more recondite among them. It is necessary to effect in the treatment of the subject a revolution analogous to that which has taken place in the natural sciences, namely, instead of beginning with theories and descending to facts, to begin with the facts and to test theories by their fitness to account for the facts." The Popular Science Monthly has always held that

there can be no substantial and lasting morality without a basis in inductive science. We maintained this at a time when the doctrine had few avowed friends and many active enemies. We are exceedingly gratified that now a dignified and ably edited magazine has been established in which this idea can have free and full expression. Among the other articles in this number of the Journal is The Law of Relativity in Ethics, in which the author, Prof. Harald Höffding, of Copenhagen University, maintains that "in an ideal state only that would be demanded of each individual which lay within his range and power." Prof. J. B. Clark, of Smith College, has a paper on The Ethics of Land Tenure, in defense of private ownership in land. Bernard Bosanquet writes on The Communication of Moral Ideas as a Function of an Ethical Society. Dr. Abbot's "Way out of Agnosticism" is criticised by Prof. Royce very fully and freely. As to this author's mode of thinking, Prof. Royce says, "Dr. Abbot's way is not careful, is not novel, and, when thus set forth to the people as new and bold and American, it is likely to do precisely as much harm to careful inquiry as it gets influence over immature or imperfectly trained minds." A brief paper on A Service of Ethics to Philosophy, by William M. Salter, of Chicago, suggests that "ethics not only enlarges our philosophy by opening to our view higher heights or deeper depths than Science is aware of, but it gives us something ultimate in philosophy, ideas that may be fairly classed as ultimate truths." The Journal's book reviews are all signed.

EMBLEMATIC MOUNDS AND ANIMAL EFFIGIES By STEPHEN D. PEET. Chicago: American Antiquarian Office. Pp 350. Price, $3.50.

THIS book is the second volume of a series to which the author has given the name of Nadaillac's work—Prehistoric America. It is devoted to describing those mounds of various shapes in our Western States which it is thought were intended to represent the forms of certain animals. The author has aimed to describe all the effigy mounds in the country; hence the volume, which is based on his own explorations in Wisconsin, Iowa, and Ohio, includes also the results gathered by other explorers in the same States and in Dakota, Georgia, and Florida. The descriptions are illustrated with two hundred and thirty-seven cuts, besides numerous plates, comprising plans of mounds, maps of the localities in which they have been found, and drawings of articles of aboriginal workmanship. The figures of mounds are generally silhouettes. The author gives the following as the points that he has sought to bring out by his explorations and descriptions: "1. The effigies were undoubtedly imitations of the wild animals which were once common in the region, but they are at the same time totemic in their character and may be supposed to represent many things in the clan life of the people. 2. The effigies are interesting as works of art, but, at the same time, they were evidently used for practical purposes, such as screens for hunters, guards for villages, foundations for houses, heaps on which sentinels were stationed. 3. There are some remarkable features embodied in the effigies which render them especially interesting, since they reveal certain strange superstitions and customs which are rarely found, but which are suggestive of the religious system prevalent in prehistoric times. 4. The question, Who built the effigies? is treated briefly, but is left undecided." The successive chapters deal with special divisions of the subject, such as the animals represented by the effigies, religious character of the emblematic mounds, the location of the effigies as related to the topography, etc. The author is editor of The American Antiquarian.

SUGAR ANALYSIS. By FERDINAND G. WIECHMANN, Ph. D. New York: John Wiley & Sons. Pp. 187. Price, $2.50.

THIS work is designed to be an authority for use in refineries, sugar-houses, experimental stations, schools of technology, etc. Within the past few years numerous new methods and modifications in old methods of sugar analysis have been brought forward, and many researches of importance to the chemistry of sugar have been accomplished. This material is scattered through so many publications, some of them being foreign journals not readily accessible, that it can be of use to the majority of American students and practicing chemists only when

the best of it is selected and embodied in a manual like the present one. The schemes of analysis here presented embrace those which, "after careful investigation, and, in many cases, after prolonged trial in practice, have seemed to the writer best adapted to the requirements of a technical laboratory." Dr. Wiechmann has avoided many repetitions by giving the methods of determining each constituent of saccharine substances once for all, and adding such suggestions as special cases call for, instead of giving a complete scheme of analysis for each product of the sugar manufacture. The opening chapters contain directions for the use of polariscopes, hydrometers, and other instruments and apparatus, for the verification of hydrometers, balances, and graduated vessels, and for the sampling of sugars and molasses. The methods for optical and chemical analysis follow, and in conclusion there are given notes on reporting sugar analyses, methods of calculating *rendement*, lists of synonyms in English, French, and German, and references to the literature of sugar analysis. Nineteen tables required in the various operations detailed are appended to the volume. These have been selected by Dr. Wiechmann with great care, and, to secure uniformity of basis, several have been calculated expressly for this volume.

PROCEEDINGS OF THE BOSTON SOCIETY OF NATURAL HISTORY. Vol. 24, Parts III and IV. Boston. Pp. 257–597.

THESE parts conclude the volume, covering the meetings of the society from May, 1889, to April, 1890, inclusive. Among the more extended papers in this portion of the volume is Mr. August F. Foerste's Notes on Clinton Group Fossils, illustrated with nine plates, and containing descriptions of a large number of species. Prof. Alpheus S. Packard contributes a paper on The Life History of *Drepana arcuata*, and another, occupying sixty-seven pages, entitled Hints on the Evolution of the Bristles, Spines, and Tubercles of Certain Caterpillars, apparently resulting from a Change from Low Feeding to Arboreal Habits, illustrated by the Life-Histories of some Notodontians. The latter is accompanied by two plates, and by figures in the text. Messrs. W. M. Davis and J. W. Wood, Jr., publish an account of The Geographic Development of Northern New Jersey, illustrated with fourteen diagrams and small maps. The scope of the investigation embraces a description of the probable course of development of the present geographical features of the highlands in New Jersey, a similar account of the formation of the central plain of the State and the highland valleys, and a discussion of the deformation of the central plain indicated by the present course of the Millstone River. Other papers are by Prof. G. F. Wright, on The Climatic Condition of the Glacial Period; by Mr. Frederick Tuckerman, on The Gustatory Organs of the Mammalia; and by Mr. Samuel H. Scudder, on The Physiognomy of the American Tertiary Hemiptera.

AMONG THE MOTHS AND BUTTERFLIES. By JULIA P. BALLARD. New York: G. P. Putnam's Sons. Pp. 237. Price, $1.50.

THIS book is a revised and enlarged edition of Insect Lives; or, Born in Prison, and is devoted to the natural history of the insects named in the title. It is written for children, but the author does not take the trouble to express herself uniformly in words with which children are familiar. The two following passages illustrate the different styles of language that are mingled throughout the volume. The first chapter opens thus: "I am only a day old! I wonder if every butterfly comes into the world to find such queer things about him? I was born in prison. I can see right through my walls; but I can't find any door." Simple enough for any child to understand; and the following sentence from the top of page 35 contrasts strangely with it: "No philosopher ever showed more patience and dignity under repeated trials at the hands of a photographer than he displayed in the hands of his persecutors, with no knowledge of the cause to stimulate his vanity and inspire his courage." This is not an isolated case. Nearly every page bristles with polysyllables, very few of which can be excused by the plea that they are needed to secure scientifically accurate description. We fear that the children who may be condemned to see nature under the guidance of Mrs. Ballard will get a much obstructed view of it. The volume is handsomely printed and liberally illustrated.

We have received in pamphlet form Prof. *Lester F. Ward's* article on *Genius and Woman's Intuition*, published in the Forum. It is a reply to an article on Woman's Intuition, by Mr. Grant Allen, who, Prof. Ward says, entirely mistakes the nature of this faculty. It is defined by Prof. Ward as a power of instantaneous accurate judgment in matters that affect the safety of the woman or her children. Out of its own field this instantaneous judgment fails to be accurate, which is the reason why men are unwilling to trust the conclusions of women on the broader questions of society and the state. Prof. Ward maintains, also, that Mr. Allen errs in identifying genius with the intuition of woman, and speaks of the former as essentially a creative faculty, which man as a rule possesses to a greater degree than woman.

The *Journal of Morphology* (Ginn) opens its fourth volume with a number containing five papers. These are The Origin of the Cerebral Cortex and the Homologies of the Optic Lobe Layers in the Lower Vertebrates, by Isaac Nakagawa; The Skeletal Anatomy of Amphiuma during its Earlier Stages, by O. P. Hay; The Segmentation of the Primitive Vertebrate Brain, by Charles F. W. McClure; and two by Mr. W. H. Howell, one being on The Life History of the Formed Elements of the Blood, especially the Red Blood Corpuscles, the other being occupied with Observations upon the Occurrence, Structure, and Function of the Giant Cells of the Marrow. Three folded plates accompany the issue.

Bulletin No. 63 of The Michigan Agricultural Experiment Station is a pamphlet on *Greenhouse Building and Heating*, by *L. R. Taft*. "The greatest defects in the ordinary forcing house," Mr. Taft says, "are, that there is generally too much wood in the roof in the shape of rafters and sash-bars, and that sufficient care is not taken to so erect them that they will not rot down, or the walls, if of brick or of masonry, be broken apart or thrown down by frost." He discusses the material for walls, the arrangement of sash bars and supports, methods of glazing, ventilating apparatus, steam and hot-water heating, etc.

*The Second Annual Report of the Storrs School Agricultural Experiment Station*, at Storrs, Conn., contains the following papers: The Acquisition of Atmospheric Nitrogen by Plants, by W. O. Atwater and C. D. Woods; Bacteria in Milk, Cream, and Butter, by H. W. Conn; Stubble and Roots of Plants as Manure, by Charles D. Woods; Meteorological Observations, by C. S. Phelps; Co-operative Field Experiments with Fertilizers, by C. S. Phelps; and Effects of Different Fertilizers upon the Composition of Corn, by Charles D. Woods.

The papers contributed to the *Second Annual Report of the Experiment Station*, at the Kansas Agricultural College, by the *Botanical Department* of the station, comprise a Report on the Loose Smuts of Cereals; an account of Experiments in Crossing Varieties of Corn; Observations on Crossed Corn the Second Year; and Brief Notes of a Preliminary Study of the Receptivity of Corn Silk. Nine plates illustrate the smuts and their natural enemies, and two are devoted to the crossed corn.

*A Chart Relative to the Composition, Digestibility, and Nutritive Value of Food* has been prepared by Prof. *Henry A. Mott* (Wiley, $1.25). It contains a large number of tables of the nature indicated by the title, the authority for each and the name of the publication from which the table is taken being given. A few general comments on the digestibility of foods are given in a foot-note.

The first number of a magazine whose purpose is indicated by its name—*Physical Culture*—has been issued in New York. Its editor is *Archibald Cuthbertson*, who says that his magazine will endeavor to avoid publishing articles simply because subscribed by a prominent name. "Physical Culture will stand or fall, not by or for lack of certain names appended to its articles, but by the quality of these attributed to them by intelligent people." Accordingly, except the opening article, "by the editor," none of the papers in this issue are signed at all, and certain marks indicate that they are mostly the product of one pen. The number contains a biographical sketch of James Douglas Andrews, illustrated with a full-page portrait of Prof. Andrews, and a view of the interior of the Brooklyn Young Men's Christian Association Gymnasium. Other articles take up The Checkley Sys-

tem, Jenness Miller and her Work, Color and Calisthenics, Prohibition, etc. The price is $2 a year.

Prof. *Robert T. Hill* contributes to the First Annual Report of the Geological Survey of Texas *A Brief Description of the Cretaceous Rocks of Texas, and their Economic Value.* The areas covered by these rocks comprise the tracts known as the Black Prairie, the Grand Prairie, the two Cross Timbers, and certain smaller regions. These form a broad belt of fertile country across the heart of the State, in which lie the principal inland cities of Texas. Prof. Hill's paper describes and locates the several deposits of chalky sands, chalky clays, and chalky limestones which make up the surface formations of this territory. The author gives also a table in which the arrangement of the rock sheets is summarized, and describes the main disturbances of the strata, illustrating them with a diagram. The several economic features of the Cretaceous system are touched upon by themselves, and the investigations in regard to them which the geologists of the survey hope to make are alluded to.

We have received an address by Colonel *George E. Waring, Jr.*, on *The Sewerage of Columbus, Ohio*, which, although largely local in application, contains also the latest views of this well-known sanitary engineer on the general subject of sewerage. An interesting discussion that followed the delivery of the address is printed with it, and brings out a number of points more fully and clearly than is usually done in continuous treatises.

The Wagner Free Institute of Science of Philadelphia devotes the third volume of its Transactions to *Contributions to the Tertiary Fauna of Florida*, by *William H. Dall.* Part I of Mr. Dall's contributions—on Pulmonate, Opisthobranchiate, and Orthodont Gastropods—occupies the whole of the volume. The text is accompanied by twelve fine plates, each containing from ten to twenty figures.

*The New England Meteorological Society* has issued a volume of *Investigations for the Year 1889*, prepared under the supervision of its new director, Prof. W. M. Davis. In addition to the tabulated reports of observers, and the review of the year's weather, which the society publishes yearly, this volume contains several papers on special topics. The most extended of these is an Investigation of the Sea-breeze, conducted by W. M. Davis, L. G. Schultz, and R. De C. Ward, with the aid of observers at over one hundred stations. There is also a short paper on Characteristics of New England Climate, by Prof. Winslow Upton.

Among the reprints which have come to us is an essay on *Tornadoes*, by *A. McAdie*, which won the second prize in a recent competition, and was published in The American Meteorological Journal. It is a technical discussion of the nature of tornadoes and the practicability of predicting them. The author believes that a careful study of the secondary whirlings in the atmosphere would reveal the causes of the seeming irregularities of the primary whirlings, and make possible not only the prediction of tornadoes, but also greater success in foretelling general weather conditions.

*William L. Green* issues from Honolulu a pamphlet under the title *Notice of Prof. James D. Dana's "Characteristics of Volcanoes,"* in which he criticises certain statements in Prof. Dana's work that differ from his own views and observations, as published in his Vestiges of the Molten Globe.

The president's address at the thirteenth annual meeting of the American Bar Association, delivered by *Henry Hitchcock*, LL. D., has been printed from the Proceedings of the Association, with the title *A Year's Legislation.* As prescribed it reviews "the most noteworthy changes in the statute law on points of general interest made in the several States and by Congress during the preceding year." The national legislation includes the Administrative Customs bill, the Dependent Pensions act, the Silver bill, and acts in relation to the World's Fair, the admission of six new States into the Union, desertions from the army, an inland quarantine, trusts, the original-package decision, and bridging the Hudson at New York. Mr. Hitchcock expresses regret that no bill had yet been passed for the relief of the Supreme and other courts of the United States. Statutes had been passed by the Legislatures of twenty-one States and Territories during the year which he covers,

and he groups those that he mentions under the heads of education and charity, protection of women and children, public safety and morals, labor and trade, legal procedure, development of natural resources, and the machinery of government. Mr. Hitchcock also glances at the Constitutions of the new Northwestern States, and calls attention to both these and the statutes above mentioned as reflecting the life and convictions of the respective communities by which they have been made.

The Ethical Societies welcome to membership all who desire to learn and practice right conduct, without requiring them to accept any particular theory. In fact, the societies as organizations do not teach a definite philosophical system, and take pains not to commit themselves to the views of their own individual lecturers. In the opinion of Dr. *Paul Carus*, they are too colorless in this respect; he thinks they should make an active search for a basis of ethics, and he has published, in a volume entitled *The Ethical Problem* (The Open Court, fifty cents), three lectures embodying his views. He maintains that a system of ethics suited to the present stage of the world must have a basis in facts and in a logical structure. "The facts to be considered in ethics," he says, "are the many and various relations in which man stands to his surroundings. These relations produce the many different motives that prompt men's actions." The function of ethics is to tell us which motives we shall resist and which we shall allow to produce action. Coming to the theories of ethics, Dr. Carus reviews supernaturalism, intuitionalism, utilitarianism, and hedonism, none of which he deems sufficient ground for a system of morality. His own theory is, that man should live not merely to secure happiness for himself, but so as to pass on to posterity a still richer "treasure of human soul-life" than he has himself inherited. But Dr. Carus leaves us still without a criterion for judging what makes human soul-life richer and higher.

Dr. *H. Carrington Bolton* has collected a considerable quantity of very curious information in a special field of coin-lore which he has published in the American Journal of Numismatics, under the title *Contributions of Alchemy to Numismatics*. The paper consists of a preliminary sketch of the aims and practices of the alchemists, followed by detailed descriptions of a large number of coins and medals struck in evidence of alleged transmutations of base metals into gold or silver. The circumstances attending the issue of most of these pieces are also given. Three of them are figured in the paper.

*A Digest of English and American Literature*, prepared by Mr. *Alfred H. West*, author of Development of English Literature and Language, and published by S. C. Griggs & Co., Chicago, presents a condensed parallel view of history and literature in England and the United States, from the time of the Roman invasion down to the present. It is intended to assist the student to that acquaintance with the characters and leading events among which he wrote which is necessary to the proper comprehension of any of the great writers. That its preparation was suggested by the author's experiences as a teacher is sufficient indication that it is intended practically to meet a real want. The pages facing one another are divided into four columns, in which are presented on one side the events and the characteristics of the period during which the writers flourished, and on the other side the writers by which those periods are distinguished, with brief accounts of their principal writings. The whole forms a connected outline of the successive periods and their literary features.

Mr. *W. H. Babcock* has made an effort, in *The Two Lost Centuries of Britain* (J. B. Lippincott Company), to restore in some shape the history of that country during the transition period of the Saxon conquest. The study is an outgrowth, as he expresses it, of an endeavor to see clearly in his own mind, and for his own purposes, a part of the life of the sixth-century Britain. In executing his purpose, incidents and periods were found linked to one another in such a way that each illustrated and was illustrated by another, and called up still others, the light of which was needed; so that the study grew into a kind of history. The author acknowledges that there may be questions as to whether what he writes is history, because he admits and preserves what is probable, but is not provable in a strict sense.

But if history be a setting forth of the past as the past really was, he reasons, the aid of inference and analogy can not be excluded. An interesting picture is presented of times of which not much is accurately known, for the composing of which the authorities of the chronicles and poems have been collated.

The chronology of historical events, originally compiled by the late *George P. Putnam*, and forming a part of his cyclopædia on The World's Progress, has been revised and brought down to the present time by *Lynds E. Jones*, and is issued in separate form by G. P. Putnam's Sons as *Tabular Views of Universal History*. The tables are arranged in parallel columns, the headings of which vary according to the charcteristics of the succeeding ages, but which usually include a column for each of the leading nations of the time, one for the world elsewhere, often one devoted to ecclesiastical affairs, and always one headed Progress of Society. For ancient Egyptian events, the chronology of Brugsch and Duncker, which puts the erection of the Great Pyramid at about 3700 B. C., is adopted as a compromise between extremes. The earliest Chaldean date is 2234 B. C., for the earliest astronomical observations; and the first Israelite date is about 1055 B. C., for the accession of Saul.

An excellent *Brief History of the Empire State* has been prepared for schools and families by *Welland Hendrick*, and is published by C. W. Bardeen, of Syracuse. The author assumes as one of the reasons why the history of New York deserves to be studied, that the importance of the colony in the making of America has been underrated. That it learned liberty under the Dutch and held to it through a century of English governors; that, handicapped by many disadvantages, it was among the first of the colonies in the war for freedom, and alone of the thirteen met every demand of Congress; and that with its canal it opened the Northwest—entitle it, he thinks, to prominent consideration at least in its own schools. There are also reasons, of a general character, for which he regards the study of State history as profitable.

*An Easy Method for Beginners in Latin* has been prepared by Prof. *Albert Harkness*, and is published by the American Book Company, with the intention of introducing the learner to such a practical and working knowledge of the Latin language as will enable him to read Cæsar or Nepos with some degree of pleasure. It approaches the subject on the practical side, introducing the student in the first lesson, without a word of grammar, to the complete Latin sentences, with verb, subject, and object.

The *Handbook of Latin Writing* of *Henry Preble* and *Charles P. Parker* grew, in the first place, out of the necessities of class work at Harvard College. The development of Latin writing there and the fuller experience of the authors have suggested modifications, and a new revised edition has been prepared and is published by Ginn & Co. The essential principle of the first edition is retained, but some of the exercises having proved less useful than they were expected to be, others have been substituted for them. The authors, attributing ill-success in Latin writing largely to the habit of translating the words rather than the thought, have been at pains to insist on fastening attention upon the thought, and have tried to show the learner how to express in Latin form the ideas which he has grasped from the English words.

The American Book Company publishes an edition of the *Satires of Juvenal*, edited, after several years of careful study, and a comparison of the views of the best critical editors, and annotated, by *Thomas B. Lindsay*, of Boston University. Thirteen of the sixteen satires are given, and from these such lines are omitted as seemed likely to offend a rational delicacy—a very proper measure for a Juvenal that is to be read in mixed classes. The notes are copious, and the whole work is richly illustrated. The author makes a comparison between Horace and Juvenal as satirists, showing that Horace wrote in a brilliant, hopeful age, and is therefore lively and amusing; while Juvenal, writing in an age of decline, when vices were rife, is contemptuous and bitter.

The short exposition of the Roman method made by *Harry Thurston Peck* in his handbook on *Latin Pronunciation* is principally intended for those persons interested in the study of Latin who have accepted the Roman method without acquainting themselves with the arguments on which it is maintained. It has now received the

approval of all Latinists of authority in Europe and America, as giving substantially the pronunciation employed by educated Romans of the Augustan age, and has been formally adopted at our leading universities. After presenting the authorities upon which it has been established, Prof. Peck concludes that "it is not too much to claim that the system of pronunciation upon which scholars are now agreed differs less from that of the Romans of the Augustan age than does our modern pronunciation of English differ from that of Shakespeare and his contemporaries." Published by Henry Holt & Co. (sixty cents).

Much pains is taken in the *Natural Speller and Word Book* (American Book Company) to teach, with the spelling of the words, the proper use of them. The dictation exercises are intended to serve to teach composition and punctuation in addition to spelling. Homonyms are made to serve for memory exercises as well as for spelling, while by introducing the best thoughts of the best authors they become really elementary lessons in literature. Synonyms are introduced to teach discrimination in the use of words, and lessons in etymology to teach the meaning of the common stem in words of like derivation. Important points to be noted in pronunciation are indicated by typographical devices.

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## POPULAR MISCELLANY.

**Intelligence in Plants.**—Mr. T. D. Ingersoll, of Erie, Pa., describes, in Garden and Forest, a Madeira vine which seemed to exhibit intelligence in its growth. When it had become eighteen inches high it began, from top-heaviness, to fall away from the pot, which stood upon a table, toward the floor. "This was done gradually, and apparently with conscious care. It seemed to feel at times that it was letting itself down too fast, when it would stop with a jerk, like a nodding child half asleep." When near the floor it began describing ellipses about three inches in diameter with its upturned extremity. When twenty-seven inches long it would describe a crescent-shaped loop seventeen inches long by six inches broad in about two hours. As it grew longer, its revolutions were accomplished with less regularity, "and at times it drooped as if weary or discouraged in trying to find something upon which it might entwine itself." On one day the track of the tip of the vine was traced and measured, and found to be six feet nine inches in length. Finally, a support was provided for the plant, and it shortly afterward "began growing again as if it had recovered from what had been for six days a condition near the point of death." Another vine, during several days of cloudy weather, uncoiled itself from the stick and reached away toward the light at an angle with the horizon of some forty-five degrees. It was brought back to its support several times and coiled about the stick, but invariably left it during the continuance of the cloudy weather. Then bright weather came on, and it showed no disposition to escape from the stick or stop its twining growth. Attempts to make plants twine in a direction contrary to their natural one were firmly resisted. "All the experiments seemed to show how much like an animal was the plant in its sensitiveness, not only to changes of light and temperature, but to harsh treatment. Whenever restrained or forced, no matter how tenderly, out of its natural method of growth, all progress was retarded and the health of the vine disturbed to a marked degree. Plants seem to be creatures of feeling, and the similarity of movement and of apparent purpose between them and the lower animals are used to strengthen their theory by those who hold to the doctrine of the identity of life in the two kingdoms."

**Modern Views of Consumption.**—Two things are now believed to be necessary for the production of consumption: the tubercle bacillus and a disordered state of the body, such as to favor its growth—in other words, seed and a fertile soil; and if either is wanting, the disease is not produced. We never know when we may take in the germs on our food or in the air, hence we should see to it that we do not give them a fertile soil. "It is of primal consequence," says Dr. S. S. Burt, in a paper recently published in the New York Medical Record, "to elevate the tone of the tissues and the fluids that bathe them to a sanitary pitch, where they themselves are the best of germicides. Bacteria do not thrive upon such nourishment." While it is almost certain that the disease itself is not inherited, it is well established that a debased quality of blood and tissue, in which the germs of consumption find their proper food, is transmitted from parent to child. If both parents come from consumptive families their children have little chance of escaping the disease, but "a child with good blood for a legacy, even from one parent," says Dr. Burt, "has every reason to expect immunity from the disease, if he is reared intelligently. Such children must be properly clothed, very carefully fed, and encouraged to spend the greater part of their daily life in the open air."

**Palm-wine.**—Palm-wine is largely used as an alcoholic drink in India and other parts of Asia, the islands of the Pacific Ocean, Africa, and some parts of America. Most trees of the palm tribe contain a sap which is rich in sugar and is readily convertible into wine. This juice is collected by making cuts in the spathe or under the crown of leaves of the tree, and catching it

in a cocoanut shell, gourd, or other vessel. The sugar is cane sugar, and is often prepared for itself. The richness of the juice is affected by the peculiarities of the species and of the tree, and its fermentability by the place of growth. The species used for wine are the oil-palm on the West Coast of Africa, the date-palm in northern Africa and India, the fan-palm and toddy-palm in India, the cocoa-palm in Ceylon and the islands of the Pacific, and the gommutti-palm in the Indian archipelago, the Moluccas, and the Philippines.

**The Indians of Northwest Canada.**—Dr. Boas, in the British Association Report on the Northwestern Tribes of the Dominion of Canada, describes the Indians of the Pacific coast as being able-bodied and muscular, with the upper limbs, owing to the strengthening of the arms and chest by the constant use of the paddle, generally better developed than the lower ones. They have a keen sight, but in old age frequently become blear-eyed. Their mental capacity is high, as is proved by the state of their culture. Whiteness of skin and slenderness of limbs are considered among the principal beauties of men and women, and long, black hair of women. In some of the tales red hair is described as a peculiar beauty of women Red paint on the face, tight-fitting bracelets and anklets of copper, nose and ear ornaments of variegated haliotis shells, and hair strewed with eagle-down, add to the natural charms. The fact that in honor of the arrival of friends the house is swept and strewed with sand, and that the people bathe at such occasions, shows that cleanliness is appreciated. The current expression is, that the house is so cleaned that no bad smell remains to offend the guest. For the same reason the Indian takes repeated baths before praying, "that he may be of agreeable smell to the deity." The Indian is grave and self-composed in all his actions; and playing is considered undignified and even bad. In the Tsimshian language the term for play means to talk to no purpose; and doing anything to no purpose is contemptible to the Indian. He is rash in anger, but does not easily lose control over his actions. He sits down or lies down sullenly for days without partaking of food, and when he rises his first thought is, not how to take revenge, but to show that he is superior to his adversary. Great pride and vanity, combined with the most susceptible jealousy, characterize all actions of the Indian. He watches that he may receive his proper share of honor at festivals; he can not endure to be ridiculed for even the slightest mistake; he carefully guards all his actions, and looks for due honor to be paid to him by friends, strangers, and subordinates. To be strong and able to sustain the pangs of hunger are evidently considered worthy of praise by the Indians; but foremost of all is wealth. It is considered the duty of every man to have pity upon the poor and hungry. Women are honored for their chastity and for being true to their husbands; children, for taking care of their parents; men, for skill and daring in hunting and for bravery in war.

**Manual Training and the Brain.**—In the discussion of Dr. Edward C. Kirk's paper on the Manual-training Idea as a Factor in Dental Education, in Philadelphia, Dr. J. L. Eisenbrey said that "the benefit to be derived from physical training means more than hand skill; it means the training of the brain man, the mental man; while you may show the effect of manual training in physical work, the result upon the brain does not come up until later on, lying back until the time calls for it; and you find that the men who occupy a conspicuous place, the young men in our profession, are the men who have had that training. To lay the foundation of a broad and complete education you need physical training, whether you get it in the city or country. I think that the country training is the best, from the simple fact that all over the whole land we find the places of trust in our banking institutions, the head places of our mechanical departments, and even in our schools of learning, filled by men who have been imported from the country, from the farm; who have handled the axe and the plow and the grubbing-hoe, who laid open the ditches and made of the swamps fruitful pastures. Physical training develops a good condition of physical health, and that means a healthful condition of the brain man; and, while it is a little slower, there comes a time when this healthful physical condition is shown in mental strength."

**A Motherly Insect.**—Among insects, as a rule, parents do not trouble themselves much about their little ones. They instinctively deposit their eggs in spots where the larvæ issuing from them will find a well-provided table, and then go away, leaving the larvæ to look out for themselves. Not so, says M. Albert Larbalétrier, in La Nature, with the earwigs. The female of this insect lays her eggs in the spring in bunches in a cool and dark place; then she sits on them, covering them in every way she can, leaving them only when she goes for food. If they get scattered she immediately finds it out, bestirs herself, looks about, and gathers them up, one by one, till she has got them together again. They hatch out during the first half of June. The larvæ are at first white, weak, imperfect in form, and hardly able to move. If left to themselves they would certainly perish very soon. The mother, however, does not leave them any more than she did her eggs; but she takes care of them, brings them food during their first days, and then guides them to the plants in the neighborhood. The little ones, too, as if aware of their weakness, do not wander away from their mother, and at the first sign of danger gather around her as chickens around a hen. The mother stays with the larvæ through all their moltings, till they are transformed into perfect insects, when she is taken away from them by death.

**The Cherokee Theory of Disease.**—The Cherokee doctor, according to Mr. James Mooney, in treating disease works to drive out a ghost or a devil. According to the Cherokee myth, disease was invented by the animals in revenge for the injuries inflicted upon them by the human race. The larger animals saw themselves killed and eaten by man, while the smaller animals, reptiles, and insects were trampled upon and wantonly tortured, until it seemed that their only hope of safety lay in devising some way to check the increase of mankind. The bears held the first council, but were unable to fix upon any plan of procedure, and dispersed without accomplishing anything. Consequently, the hunter never asks pardon of the bear when he kills one. Next the deer assembled, and, after much discussion, invented rheumatism, but decreed at the same time that if the hunter, driven by necessity to kill a deer, should ask its pardon according to a certain formula, he should not be injured. Since then, every hunter who has been initiated into the mysteries, asks pardon of the slain deer. When this is neglected, through ignorance or carelessness, the "Little Deer," the chief of the deer tribe, who can never die or be wounded, tracks the hunter to his home by the blood-drops on the ground, and puts the rheumatism spirit into him. Sometimes the hunter, on starting to return to his home, builds a fire in the trail behind him to prevent pursuit by the Little Deer. Later on, councils were held by other animals, birds, fishes, reptiles, and insects, each one inventing some new disease to inflict upon humanity, down even to the grub-worm, who became so elated at the bright prospect in view that in his joy he sprang into the air, but fell over backward and had to wriggle off on his back, as the grub-worm does to this day. When the plants, who were friendly to the human race, heard what had been done by the animals, they held a council, and each plant agreed to furnish a remedy for some corresponding disease when man should call upon it for help. While the great majority of diseases are thus caused by revengeful animal spirits, some are also caused by ghosts, witches, or violations of ceremonial regulations.

**Instinctive Movements of Children.**—M. Alfred Binet maintains, in the Revue Philosophique, that the attempts of infants to walk are instinctive, and not the result of education. This seems to be indicated by the more or less correlated movements which an infant only three weeks old will keep up if the soles of its feet are allowed to touch lightly a suitable surface. M. Binet believes that the time at which a child learns to walk depends, not on bodily conditions only, but on its mental characteristics also. He thinks he has established as a fact that a child that can give its mind to placing its steps, and whose attention is not easily distracted, learns to walk at an earlier age and in a shorter time than more restless children; and that such children are characterized in later life by the important faculty of

close application to work. He remarks that the restless movements of young infants are almost always bilateral, though the two sides may be affected either synchronously or alternately. If an India-rubber ball connected with a tracing apparatus be placed in each hand of an intelligent child, and he be told to squeeze with one hand only, the tracing almost invariably shows that the ball had also been squeezed, but with less force, by the other hand. The "reaction time"—the interval between the giving of a signal and the performance of a prearranged movement—was found to be double that in healthy adults, and the duration of the contraction three times as long. M. Binet's observations indicate, against the conclusions of Mill and Bain, that our ideas of space are instinctive. A child three months old, who, the author is certain, had never had a fall, and was therefore without experience of its discomforts, would lie contentedly across a person's outstretched arms, if the hands were placed in such a position as to prevent its slipping down. If, however, the hands and arms were depressed, so that the infant would tend to slide down, it would show its fear by at once screaming and struggling.

**Philosophy of Some Assassinations.**—By the customs of some countries kings are not permitted to die natural deaths, but must be killed by their successors. An attempt to explain this usage is made by Mr. J. G. Fraser, in his Golden Bough. In primitive thought kings are credited with the possession of powers of the utmost importance and value to their worshipers. In Japan the existence of the globe and all that is upon it was supposed to depend upon the well-being of the Mikado. Yet kings or man-gods were subject to the law of death like ordinary mortals; and in the case of death the soul was believed to be extracted from the body by the wiles of a demon or sorcerer, or else voluntarily to go away never to return, and in either case to be lost, with all its virtues and benefits, to the worshipers. But if the soul could be caught in the act of escaping, and in full vigor, then it might still be kept present with the people. Hence the only way of security was to kill the man-god in order to make sure of catching his soul; and to kill him when in full vigor, in order that the soul might be transferred with all its energies unimpaired to the body of a suitable successor. "The people of Congo believed that if their pontiff, the Chitomé, were to die a natural death, the world would perish, and the earth, which he alone retained by his power and merit, would be immediately annihilated. Accordingly, when he fell ill and seemed likely to die, the man who was destined to be his successor entered the pontiff's house with a rope or a club and strangled or clubbed him to death. . . . In the kingdom of Unyoro, in central Africa, custom still requires that, as soon as the king falls seriously ill or begins to break down from age, he shall be killed by his own wives; for, according to an old prophecy, the throne will pass away from the dynasty in the event of the king dying a natural death." There are instances in which the king is allowed to reign only for a definite term, fixed independently of the signs of disease and decay, and at the end of which he is either killed by his successor or he immolates himself. Formerly the reign of the king of Calicut was thus limited to twelve years, after which he was obliged to cut his throat in public. Under a subsequent modification of the rule a great feast was made at the end of the appointed time, and, when this was over, any guest who, after fighting his way through the guards, succeeded in killing the king, was allowed to reign in his stead. "So long as the king could maintain his position by the strong hand, it might be inferred that his natural force was not abated; whereas his defeat and death at the hands of another proved that his strength was beginning to fail, and that it was time his divine life should be lodged in a less dilapidated tabernacle."

**The Zungarian Desert.**—The desert region called Zungaria, which lies on the western borders of Mongolia, rises to a height of about twenty-five hundred feet, but descends from it at many points. The soil is chiefly composed of the clay called loess, a mixture of very fine sand and a gray or yellowish calcareous earth. This argillaceous mass is pierced, like a sponge, by numerous tubes or pores, which are often lined with incrustations formed by herbaceous plants. The

winds and the rain shape these deposits into abrupt, elevated, square-cut masses. This property of forming a kind of vertical cliffs, with the porous texture and the absence of stratification, are characteristic of the loess, as is also the presence of terrestrial or lacustrine remains instead of sea-fossils. Being exceedingly fine in constitution and well charged with certain salts, the loess is generally, when well irrigated, exceedingly fertile. In all the tillable regions of central Asia, including China, it plays the same part as the "black earth" of Russia. The mountains which form on the south the western border of Zungaria are rich in minerals. Gold is an important product of the region of Khotan, where there are twenty-two mines, some of them employing three or four thousand workmen. This region has long enjoyed the honor of being the only known place where nephrite or jade was found. The beds of that rare substance are in the district of Kárakach; but the quarrying for it has greatly fallen off since the disturbances that occurred during the brief reign of Yacoub Beg in Kashgar.

**A Young Trader of the Solomon Islands.**—It is amusing, says Mr. Woodford, in his Naturalist among the Head-hunters, to see a mere child paddle alongside in a crazy trough of a canoe, only just capable of supporting its weight. "The water splashes into the canoe at every stroke of the paddle, and at intervals the small child kicks it overboard with his foot—a novel kind of baler. Three or four moldy-looking yams, ostentatiously displayed, are rolling about in the water at the bottom of the canoe. The unsuspecting stranger takes pity on the tender years and apparent anxiety of the small native to trade, and gives him probably four times the price for his rusty yams. The child eagerly seizes the coveted stick of tobacco, and immediately stows it for safety through a hole in his ear, where at least it will be in no danger of getting wet. He next whisks aside a dirty-looking piece of matting that has apparently got accidentally jammed in one end of the canoe, and displays some more yams, of a slightly better quality than the last. For the sake of consistency you can not well offer him less than you did before, and another stick of tobacco changes hands and is transferred to the other ear. You think now that he must have finished, as there is no place in the canoe to hide anything else, but with a dexterous jerk that nearly upsets the canoe he produces a single yam that he has been sitting upon. How it managed to escape notice before is a puzzle. For this he demands a pipe, but is not satisfied with the first or second that is shown him. No; he must have a *piala tinoni*, or have his yam back. The *piala tinoni* is a pipe with a man's face upon the bowl. But again the young trader is particular; it must also have a knob at the bottom, or he will have none of it."

**Population of Cheese.**—M. Adametz, of Somthal, Switzerland, has been making a census of the microscopic animalcules in cheese. In the fresh cheese of Emmenthal he finds from 90,000 to 140,000 microbes to a gramme, the number increasing with time—a cheese 71 days old had 800,000 to the gramme. The population of mild cheese (*fromage mou*) was still more dense. At 25 days of age it was 1,200,000; at 45 days, 200,000,000 microbes per gramme. These figures apply to the middle of the cheese, while the population is much more dense toward the outside, where it rises to from 3,600,000 to 5,600,000. At this rate, the number of living beings in 360 grammes of cheese is as great as the number of men on the globe.

**Green Seeds and Early Fruit.**—Correspondents of Garden and Forest remark upon the evidence afforded by recent experiments that seeds from immature fruit will give a product requiring less than the usual time to ripen, and that the earliness thus gained can be increased by continuing the selection. This has been observed, according to Dr. E. Lewis Sturtevant, at the New York Experiment Station, in the case of varieties of corn, turnip, and cabbage. At Purdue University, Indiana, a gain of from fifteen to twenty days has been obtained by early selection. Prof. Arthur, of Purdue University, has observed further that the plant as well as the fruit thus cultivated tends to early ripeness, and hence the period of fruitfulness, or the time between the first and the last ripe fruit,

is much shortened. With the increase in the amount of fruit, according to Prof. Arthur, there is also a corresponding decrease in the size of the vegetative parts of the plant—that is, the stems and foliage. A tomato plant grown from green seed in the fourth generation was found to bear three and a fourth times as much fruit as top or stems and leaves together, while a similar plant from ripe seed had only one and an eighth times as much fruit as tops. It follows that, while earliness may be considered as a usual condition in all crops from unripe seed, an increase in the amount of the crop occurs only when the true fruit is the part harvested, as in tomatoes and peas, and a decrease in the amount of the crop occurs when any part besides the fruit is harvested, as in turnips and potatoes.

**Imitative Coloring of Animals and Plants.**—Among the later papers by Mr. Proctor in "Knowledge" is a study of color-mimicry in animals and flowers. It was suggested by observing a chameleon among the green leaves of an ivy, where it was as green as they. A fly of nearly similar color came along, and was instantly caught by the animal's nimble tongue. Afterward the chameleon settled on one of the sticks supporting the ivy, "and there it gradually assumed the same color, so far harmonizing with the stick that he seemed only an excrescence upon it, not a live creature which a short time before had been light green in color." This incident suggests some other illustrations of various forms in which color affects the development of life. Consider, continues Mr. Proctor, the striped tiger as an example of color in an animal that lives by preying on others, and the zebra as an example of color in an animal whose life depends on its not becoming the prey of carnivorous animals. "We can understand how, in certain regions, those members of feline races who chanced to have markings on their bodies which corresponded in appearance with the stems of trees, or with jungle reeds, and the like, would be better able to remain concealed till the animals which formed their prey came within certain range of their spring, and so would have the best chances of living"; and in like manner it is manifestly to the advantage of the zebra, when sleeping in the shade of trees, "to have markings on his body which from a distance would be confounded with the stems of trees and shrubs, beneath which for a while his active limbs were at rest. For so would he best escape the attacks of animals of prey. It is noteworthy that, when the zebra is stretched on the ground, the stripes on his legs as well as those on his body are vertical as seen from a distance. The same is the case in the tiger's stripes when the animal is couched for a spring." Another topic for speculation is the persistency of these imitative characteristics, which often appear as sports in the descendants of these animals ages after the purpose of their adaptation has ceased to exist. The author's attention was directed, while he was writing, to a sandy-colored cat "marked with stripes such as hundreds of thousands of years ago were of value to its remote ancestors in the struggle for life"; and a mule plowing in a field near his house had rings around his legs precisely corresponding to rings on the same parts in the zebra. In the vegetable world, color seems to be in all cases dependent on the requirements of propagation. Thus, where seeds are diffused by animals, as with the berries, we find the fruits brightly colored, to attract the attention of the animal distributors. It will be noticed that, when seeds are distributed by the winds, bright colors are not found in the fruit, even though the plant be closely allied to species distributed by animals in which the bright colors are present.

**Bristling with Fire.**—Photographic pictures of the smoke issuing from the mouth of a cannon at the moment it is fired show thin trails of fire about the circumference of the smoke-cloud, which give its edge the appearance of a porcupine's back bristling with quills. The trails are caused by the ignition of cubes of the pebble-powder which have been shot from the gun before the combustion was completed. Prof. W. Mattieu Williams has found, by examining the papers of Count Rumford, that he made experiments on the same subject, from which he inferred that in the ordinary firing of gunpowder in firearms the explosion must be gradual. In using powder in grains and cubes of sizes proportioned to the caliber of their guns, modern artillerists are only car-

rying out the principles which Rumford expounded. He foretold the danger of firing such artillery as we now use with ordinary small-grain powder. Such powder would explode completely before the shot could fairly be set in motion, and would produce bad effects on the gun. The modern cubes burn on their surface and thereby start the ball. They continue burning and evolving more and more gas as the ball travels along the tube, and, to be perfect, should just complete their combustion as it leaves the mouth of the gun. But this degree of perfection is not attained, and hence we have the "porcupine-quills" appearance.

**Horse-Sausages.**—The best Bologna sausages are made of chopped bacon and pea-flour, and are flavored chiefly with garlic and cloves. When the bacon is old, but sound, says the Sanitarian, such sausages are wholesome and highly nutritious, and are especially useful to laborers, travelers, and soldiers in camp, and others who have not the means of cooking at hand. They rarely spoil, but, being eaten uncooked, they may sometimes introduce trichinæ. The use of horse-flesh is a recent innovation in sausage manufacture, and is practiced in Italy and Belgium, as well as in this country. These horse-sausages are said to be of the Bologna variety, and the makers justify them from the wholesomeness of horse-flesh when healthy. But the meat actually used is that of animals worn out by work or made useless by disease—"fit for nothing else."

**The Médoc Wines.**—The Médoc district of France, famous for its wines, consists of a long strip of land, extending northerly from Bordeaux and lying between the sea and the river Gironde. The best vines are grown on a surface of gravel-quartz and sand with a clay subsoil. The vine most usually grown is of a stunted variety, and seldom rises more than two feet from the ground. They first bear about five years after being planted, and continue productive for one hundred or even two hundred years. The grapes, when taken to the press-house, are stripped from the stalks and placed in large vats, some of which have a capacity of 3,240 gallons apiece. In these they are left to ferment for a period of from a week to a fortnight, after which the wine is drawn off into hogsheads and taken to cool in well-ventilated stores. Here the casks are filled up at intervals, and the drawings-off are attended to at the proper time. Tendency to excessive fermentation is checked by drawing the wine off into casks impregnated with sulphur. The Médoc wines are classified into several grades or growths, the qualities of which are considerably capricious; and the quantity of wine produced at the several vineyards is subject to great fluctuations. Notwithstanding, however, the uncertainty of the annual return, the Médoc district is said to be of greater commercial value to France than both the better known Cognac and Champagne districts put together.

## NOTES.

In respect to the use of the diamond drill, or an instrument of corresponding effectiveness, by the ancient Egyptians, Mr. W. F. Durfee, having inquired through our consul-general at Cairo, received from Mr. W. Flinders Petrie the following list of objects in which marks of such an instrument may be seen: Base of tube-drill hole, cut too deep in roughing out the statue, between the feet of the diorite statue of Chafra (Kofra), in the Boulak Museum; sides of two drill-holes, showing on the inside of the sarcophagus at Gizeh; the marks are near the top, at the north end of the east side, and on the west end; saw-cut too deep into the outside of that sarcophagus, on the north end, near the top at the northeast edge; saw-cut surface beneath the sarcophagus in the second pyramid at Gizeh; drill-hole with core sticking in it, in the granite lintel of the chamber leading from the southwest corner of the great hall of the granite temple of Gizeh, the fifth hole. Mr. Petrie believes there are some small drill-holes in the Hyksos head in black granite from Bubastis, in the Boulak Museum, where the eye-sockets have been cut out.

The importance of taking care of the first teeth is insisted on by Mr. Fisher, a dentist of Dundee. While they are destined to disappear in a short time and give place to other teeth, they will cause pain and general conditions of disease if they are unsound, the same as the permanent teeth do; and the latter can not escape being affected by the disorders they occasion. It is not safe to depend on extracting them if they cause pain, for that enfeebles the chewing power; and, if many of them are removed, the jaw does not develop properly, and the second teeth are made liable to grow irregularly.

THE respiration of insects has been the subject of study by M. Contejean, who has found that, contrary to what takes place in vertebrates, the movement of inspiration is passive and that of expiration active. The air is driven from the body by a contractile effort. Hence, when the insect is wounded, the flow of blood occurs at each expiration. The respiratory movement is not interrupted by cutting off the head, nor by the absorption of curare, which produces an immediate cessation in man.

DR. G. MEYER thinks that he is able to assume, from a comparison of the records of a number of years, that the moon has an influence in lowering the height of the barometer in the months from September to January, at the time of full moon, and in raising it during the first quarter. His views are confirmed by the independent studies of Captain Seemann, of the Deutsche Seewarte. No effect has been perceived in the other months.

THE property marking bacteria and bacilli of absorbing aniline and being killed by it has been put to good use by two German observers, Messrs. Stilling and Wortmann. Having demonstrated that the violet aniline dyes, without arsenic, were not poisonous to rabbits and guinea-pigs, the authors produced eye-disorders in those animals, and treated them successfully with aniline. They then tried the human subject, and cured a skin-ulcer on a scrofulous child, by daily dropping a little aniline solution on the sore. Similar good results were had with bad cases of eye disease; and it soon appeared that many surgical cases were open to treatment in this way, and that, in general, wounds and sores developing suppuration could be sterilized with aniline. It is thought that cases of internal inflammation may also be within reach of this treatment.

PENSIONS have been granted in the English civil list to Dr. Huggins, the widow of the Rev. J. G. Wood, and the four unmarried daughters of the late Rev. M. J. Berkeley.

MR. G. W. HAMBLETON regards consumption as depending on conditions that reduce the breathing surface of the lungs below a certain proportion to the rest of the body. The conditions include sedentary overcrowding, want of exercise, defective seats, ill-fitting clothes, and whatever may impair the lungs or lead to undue compression of the chest. Remedies should be sought in free country life, well-ventilated rooms, suitable chairs, and clothing free from constriction and not too heavy. The earliest physical training should aim at the full development of the thorax. Persons whose breathing capacity does not measure up to the normal should not engage in any occupation tending to constrain the chest or to expose the lungs to the inhalation of dust.

PROF. F. W. OLIVER has published a paper on the floral biology of the flower *Episcia maculata*, a plant which, recently sent over from British Guiana, first flowered at Kew last summer. It is remarkable in that the flowers are never open, but the front lobe of the corolla is from the first folded back, so as to close the mouth like a cork. Nevertheless, all the arrangements are such as are adapted for cross-fertilization by the agency of some insect. The plant is unique in being at once closed and yet requiring the visit of an insect for its fertilization.

ADVANTAGE is to be taken of the height of the Eiffel Tower to fix in it a manometric tube in which mercury can be poured to form a column that will give a pressure of four hundred atmospheres. M. Cailletet hopes to be able to make use of this enormous pressure in continuing his experiments on the liquefaction of gases.

A DEPOSIT of floridite, or phosphate of lime, described by Prof. E. T. Cox as found in Florida, occurs in beds from a few feet to thirty-seven or more feet deep at places, over an area of 120 miles north and south, and 20 miles east and west, and consists of 80 per cent pure phosphate. The author believes that it is derived from the mineralization of an ancient guano.

THE crumpled and crushed form of the human ear is accounted for by Prof. H. D. Garrison as a result of the habit of lying on the side of the head, which habit has been induced by the increasing weight of the brain. The question, says the author, in his paper on the subject, read at the American Association, had originally been whether the animals through which it had been developed would profit most by large brains or by perfect and symmetrical hearing apparatus, and had been promptly decided by natural selection in favor of large brains.

THE Biological Section of the American Association has approved of a movement to establish a biological station on the Gulf of Mexico, for which subscriptions of $25,000 have been promised. The station will probably be located at Tarpon Springs, Fla., where there are fine opportunities for the study of fresh and salt water, as well as of land forms.

DR. WILLIAM HUGGINS has been chosen to be President of the next year's meeting of the British Association to be held in Cardiff, Wales. The meeting of the Association in 1892 will be held in Edinburgh.

PROF. A. J. COOK, speaking of the Food of Bees, remarks that the carbohydrates are sufficient for the life of the insects, but that they must have nitrogenous food to support them during the process of reproduction. The former they derive from the honey of plants, the latter from spores, grain, fungi, and bee-bread.

CONCERNING certain philological and ethnological discussions that are going on with considerable warmth, Mr. John Evans said, in his address in the British Association, that it will be for the benefit of science for speculations as to the origin and home of the Aryan family to be rife; but it will still more effectually conduce to our eventual knowledge of this most interesting question if it be consistently borne in mind that they are but speculations.

AN important manufacture of butter from cocoanut-milk is growing up in Germany. Cocoanuts for the purpose are imported in large numbers from India.

RECENT investigations by Prof. Geddes, of Edinburgh, have led him to reject the commonly accepted views of the origin of thorns. He has found that there is a more or less developed general contrast in vegetative habit between thornless and thorny varieties. The thorny varieties or species show a more diminishing vegetativeness than their thornless congeners; in fact, they frequently develop their thorns by the actual death of their germ points.

THE presidential address of Prof. T. E. Thorpe, in the Chemical Section of the British Association, was largely devoted to the vindication of the claims of Priestley to be the discoverer of oxygen and of the non-elementary nature of water, against the attempt of M. Berthelot, in his Révolution Chimique, to appropriate a principal share in the discoveries to Lavoisier.

A NOTION has been put forth by the editor of a leading dairy paper that neither dipping out milk nor drawing it through a faucet from large cans gives portions of equal quality to every customer. The dipping method was tested, at Cornell, on three milk routes—the conclusion reached being that by this practice "substantial justice is done all the patrons so far as the amount of fat apportioned to each is concerned."

## OBITUARY NOTES.

SIR RICHARD F. BURTON, who died at Trieste, Austria, October 30th, was one of the most venturesome travelers and explorers and voluminous authors of modern times. He was born in Hertfordshire, England, in 1821. Having no taste for the university, he entered the East India and afterward the British diplomatic service. He visited the holy places of Arabia and won fame by the book he wrote about them; was the first European to visit Herat; discovered Lake Tanganyika; traveled to Salt Lake City and California; spent three or four years in western Africa; explored the Brazilian highlands and Paraguay; spent two vacations in "unexplored Syria"; visited Iceland; explored the land of Midian; and accompanied Cameron to the Gold Coast. His published works approach eighty volumes, of which thirty-nine are accounts of travel and exploration. Of these the Lake Region of Equatorial Africa is one of the best books on Africa. Burton also published grammars of three Oriental languages, five volumes of folk-lore, three books on fencing, and translations of the Portuguese poet Camoëns, and of the Arabian Nights.

MR. JOHN HANCOCK, an English ornithologist, died at his home in Newcastle-on-Tyne, October 11th, at the age of eighty-nine years.

THE death is announced of Dr. Wenzel Leopold Gruber, Professor of Anatomy in the University of St. Petersburg. He was seventy-six years old.

PROF. THOROLD ROGERS, the eminent English economist, has recently died at Oxford. He was educated at King's College, London, and at Oxford, and began life as a clergyman of the Puseyite school. He afterward became a "coach" at Oxford, where he wrote a hand-book on Education and a pamphlet on the Law of Settlement. He was made Professor of Political Economy at Oxford in 1862, after which he devoted himself mainly to economical subjects, and entered Parliament in 1880. He published two volumes of Historical Sketches; Cobden and Modern Political Opinion; Agriculture and Prices in England (his most important work); Six Centuries of Work and Labor; The Economical Interpretation of History; and the History of Holland in the Story of the Nations series.

MR. ROBERT BROUGH SMYTH, of Victoria, Australia, who died in August last, had an important part in the scientific work of the colonies. He was from 1855 to 1858 Director of Meteorological Observations for the Colony of Victoria; was for some years member and Secretary of the Board of Science; honorary secretary and member of the Board for the Protection of Aborigines; Director of the Geological Survey of the Colony; and author of many works and papers on geology, ethnology, and philology.

CAPTAIN JOHN PAGE, of the Argentine Navy, a summary of whose lecture on the Gran Chaco and its rivers has been published in the Monthly, died in June or July while making an attempt to explore the Pilcomayo River at about one hundred and fifty leagues from its mouth. The expedition reached the mouth of the river in the small steamer General Paz in April last, and Captain Page attempted the ascent thence in a vessel built especially for the service, drawing only eight inches of water; but even then the ascent was found impracticable, and the steamer could often be kept afloat only by damming up the stream.